THE TELEGRAPHIC JOURNAL AND

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THE GOVERNMENT AND THE TELEPHONE COMPANIES.

THE Postmaster-General, in replying to a deputation which waited upon him on Friday last at the residence of Mr. Staveley Hill, M.P., Oxley, Wolverhampton, with the object, amongst others, of urging a more complete development of the telephone system, is reported to have remarked that it was unsatisfactory that the Government should have to compete with private firms, and that before long the system must be taken up by the Government and telephones placed on the same footing as telegraphs, and be controlled altogether by the Government.

This announcement which, although perhaps not altogether unexpected, was yet a surprise to many, has since been withdrawn. Nevertheless, the observations thus elicited by the deputation serve sufficiently well to indicate the impression which exists in official quarters. The policy of the Postal Telegraph Department in ignoring for so long a period the competition to which telephonic communication must, in the long run, subject it, is doubtless to many inexplicable. Why, on the Law Courts having decided that the telephone was a telegraph instrument, and consequently that all public communications sent by its means were amenable to a charge to be fixed by the State in recognition of the monopoly entrusted to it on the purchase of the telegraphs, the Government did not forthwith acquire the telephone patents for Great Britain and put them into operation for the use and extension of the commerce of the country is also a question which many will have asked themselves. That a Department established for the purpose of developing to their fullest extent the resources of electrical communication should have taken this course would appear to most people but right and reasonable. That the telephone system as an adjunct to the telegraphic system fostered and nourished by a Government branch of the State, upon broad and sound principles, would have shown a condition of things very different from that which, as regards telephone enterprise, at present exists, all will agree. The policy pursued by those in whose hands rests the mainspring of the telephone enterprise of the country has never been such as to obtain from us any amount of enthusiastic admiration. This policy has not, in our opinion, been marked by that broad and comprehensive treatment which goes so far towards securing the good feeling and sympathy of the community at large. To this day, although the master patents of the invention have nearly expired, the advantages of the telephone are practically restricted to the well-to-do—the small and energetic tradesman is obliged to deny himself the aid it would doubtless be to him, for the reason that he cannot afford the annual charges which embrace its employment. It is, of course, possible that the telephones in the hands of the Government may do no better; but this we hardly think will be the case. Whether the Government takes the control into its hands or not no great time has to elapse ere every man will be able to manufacture, erect and work his own telephonic communication, that is for his own private uses. Should the thing fall into the hands of the Telegraph Department ere this date, the public will certainly reap advantages equal to those they now enjoy, or may reasonably anticipate, whilst the management of the exchange systems being brought more closely into connection with the telegraphic system, and moreover being placed under the control of a Department always, to some extent, amenable to public enquiry and public opinion, must prove beneficial. We cannot, then, but regard the expression of the Postmaster-General upon this question as one which will be welcomed by the country at large.

The question which the acquisition involves is one of considerable magnitude. As we have already indicated there was a time when the matter was simple; when the Government had merely to deal with the purchase of a system hardly established. Since that period, however, telephone exchange enterprise has made considerable advances, and has practically settled itself to compete with telegraphic communication. There can be no doubt that at this period there are passing between many of our large business centres *viva voce* communications which, were it not for the telephone, would pass over the Government wires, and the sixpences for which would go into the coffers of the Telegraph Department. True it is that the Government gets a percentage on the rentals for these communications, but it is open to grave doubt whether this mode is so remunerative as would be the direct payment per word. The days for that, however, are gone by. Telephonic communication between place and place, large centre and small, is an established fact. The public have enjoyed it, and it must be continued. The question which the Government has to face is, whether it shall see that for the furtherance of which it was entrusted with exceptional powers, pass out of its hands, or whether it shall, without further loss of time, step out and deal with the question upon those broad principles which would earn for it the support of the entire community. Telephonic communication has become a necessity of the time. It is bound to become more and more so. In the hands of a public Department its progress must undoubtedly become greater than is possible situated as it now is; but the thing requires handling in no half-hearted manner, and we hope, in spite of the withdrawal of the observations to which we have referred, the time is not far distant when we shall see that impetus given to telephonic communication which it has lacked since its introduction into England.

We have said that we are not admirers of the manner in which telephonic interests have been administered at the hands of the initiative power,

This is so, but it is also due to those who exercise this initiative power to say that we are by no means insensible to the fact that difficulties have beset their way. They have been placed in a position almost antagonistic to a Government Department. Controlled to such an extent by that Department as to limit to a certain degree their progress for, at least, a considerable period, there has not been that open field for work which other countries have afforded.

The subject is one of general interest, the progress of which will be watched, not only by ourselves but by others, and we hope to be able to return to it again shortly.

THE *Star*, the latest of our newspapers has on its staff an "Electrical Man," Dr. J. E. Taylor, who bids fair to outdo the scientists of the *Times* and *Morning Post* put together. We learn that Messrs. Holmes, of Newcastle, have brought out a new dynamo with *wrought iron* field magnets, which are said to be wonderfully efficient, but the brush holders are said to be the most important feature, as they have an arrangement to regulate the pressure. This is very wonderful and the novelty of the arrangements will no doubt be fully appreciated by the inventors, but more remains to be said. "We don't know all that is knowable about iron yet, and we know less about magnetism," says this new addition to the army of electrical scribes. "A French scientist M. Ledeboer, has shown that not only does an *iron* magnet lose its magnetism when raised to a red heat, but that up to a temperature of 650 degrees centigrade it is still magnetic. Singularly enough the magnetism returns when the iron cools down again." This description of well known phenomena is somewhat involved and obscure, but when we state that the iron bar was placed in a magnetising coil, it will gradually dawn upon the mind what Dr. J. E. Taylor was driving at. Briefly stated, iron at temperatures below 680 degrees centigrade retains sensibly the same magnetic properties as when cold, but beyond this temperature the fall is very rapid, for at 750 degrees the magnetic properties scarcely exist, and at 770 degrees they completely disappear.

IT appears to be well within the range of possibility, that electric lighting by incandescence will be threatened with a very serious competition in the form of the Clamond incandescent gas light, which is said to give over five candle-power per cubic foot of gas consumed per hour. The conical hood or burner is the only expense, and this, which can be fitted to any nipple, is composed of filaments of magnesia, and it is claimed that by its use very little smoke or free carbon is given off, thereby almost entirely avoiding decorative deterioration. Colours can be matched as easily as in daylight, and the prospectus of the company distinctly makes it understood that the Clamond light is considered to be quite equal, if not superior, to the incandescent electric lamp, and that it is barely distinguishable from it. We are aware that several improvements in gas lighting of a similar nature have been brought before the public recently, without, we believe, occasioning any falling off in the electric lamp industry, but we cannot help thinking that the Clamond system is far more likely to cause a certain degree of anxiety than previous chemes, such as the Welsbach. The rapid destruction of the hood appeared to be the weak spot in the last mentioned principle, and although time only will show how far the Clamond burner is superior in this respect, the promoters of the company make bold to publicly declare that the invention will enable the gas companies to more than hold their own against electric lighting. The latter method of illumination is offered from central stations at a price equivalent to gas, at 6s. per 1,000 cubic feet, but the Clamond company proposes to double the amount of light obtainable from ordinary gas at its present price, without any further cost than that of applying a magnesia hood, wherein, however, lies the success or failure of the project.

THE improvements in dynamo-electric machinery devised by Messrs. Crompton and Swinburne, to which we briefly referred last week, may be found in another part of this journal. It has been said that Mr. Swinburne entered for the electro-motor competition organised by a contemporary, and that he tried hard to devise the most wild and apparently impossible form of apparatus which his restless brain could conceive. He did not get the prize, however, and probably for this reason he felt certain that his motor had some good points about it, and, in combination with Mr. Crompton, the present development of the idea was carried out. The dynamo armature is very like a Rankin Kennedy transformer, or a Pacinotti ring with an iron sheath around its periphery. The invention is such a departure from accepted methods of constructing dynamos that much speculation will result as to the performance of the machines, and we shall await with interest the data obtained. We do not think that many of our readers would attempt to forecast the "characteristic."

PERSONS who have been wilfully and maliciously employing any form of electric battery for lighting or other purposes in connection with any movable article of furniture had better beware. Mr. A Gray is the proprietor of the patents covering the use of such combinations, and is on the war path. Read the following, ye triflers with another's patented idea, and tremble:

[COPY]

29, Essex Street, Strand, London, W.C.

Gentlemen,—It having come to the knowledge of my client, Mr. A. Gray, that there have been extensive infringements of his rights under his patent No. 7,244, of 5th May, 1884, I hereby beg to give you notice that all batteries, both primary and secondary, fitted to articles of movable furniture which are not connected with any outside electrical supply constitute an infringement of his patent rights.

My client is willing to grant licenses on moderate terms for the use of his patent, and on hearing from you I shall be glad to enter into negotiations for that purpose.

I am also empowered to treat for the sale of this valuable invention.

Yours faithfully,

WM. L. COOPER.

This extraordinary communication has evidently been pretty extensively circulated, for the copy which has found its way into our possession is lithographed. We may be guilty of an act tending to defraud this ingenious inventor of his just rights, but we cannot refrain from advising such of our readers as may have wickedly indulged in electric table lamps to immediately detach (not electrically, of course!) their batteries from the lamps and place them under the table, or to clamp the table bearing the wonderful combination to the floor, so that it will be no longer "movable."

THE date upon which Parliament will once more enter upon its labours is fast approaching, and it behoves those who are interested in the progress of

electric lighting to be stirring, in order that public opinion may be aroused to the necessity for amending the existing restrictive law affecting the industry. Major Flood-Page is early in the field, and his able letter in the *Times* and other papers this week should have some effect in re-awakening interest in the minds of the Government, of our legislators generally, and, in fact, of all who can have any influence in the direction of bringing about a change in the present condition of the Act relating to electric lighting. Democratic theories find great favour just now, and those who profess the welfare of "the people" can scarcely refuse their aid to a movement which, Major Page is confident, would result in some 100,000 men, women and children finding healthy and profitable employment.

IT looks as if the new compound-winding suit will really be brought to a definite legal issue. The case of Messrs. King, Brown and Company, of Edinburgh, was called on Saturday last, and it was expected that the Brush Corporation would have to put in an appearance on Wednesday or yesterday and lodge written answers to the Scotch firm's summons seven days after. We are informed that we were labouring under a misapprehension with regard to the distinction between English and Scotch law. Any final decision in the latter court is, we are assured, binding for the whole of the United Kingdom; but of course, as in the case of the English courts, appeal may be made to the House of Lords. The letter from the Brush Corporation, which we publish to-day, puts a somewhat different complexion on the matter.

WE are glad to see that Mr. Crompton has been successful in the suit brought against him by the Witkowitz Company, it being proved that the boilers supplied by that firm were utterly defective. The total cost to the Witkowitz Company, of professional expenses, of witnesses, fines, and replacing the defective boilers by new ones, will probably amount to over £10,000.

MR. LYND has done good service by drawing attention to certain portions of the Bournemouth surveyor's report to the Commissioners of that town on the proposed scheme for erecting an electric lighting station. That gentleman probably saw a transformer silently performing its duty, and quite overlooked the fact that its functions were dependent upon steam engines and alternating current dynamos. We trust that the true state of the case will at once be laid before the Commissioners.

Mr. EDWARD BLAKE recently read a paper before the Boston Electric Club on the "Electrical Distribution of Energy." The chief feature in the discussion was the remarkable ideas of a Mr. Wilson concerning electro-motors. This gentleman, who was simply irrepressible, notwithsanding the efforts of Prof. Elihu Thomson, Mr. E. W. Rice, and other electricians to keep him on the track, declared that the counter electromotive force in a motor was a disadvantage, and that, theoretically, a perfect motor was one that would distribute power without counter E.M.F.; nothing would convince him to the contrary. Mr. Wilson is only a little behind the times. It is not so long ago that a well-known motor manufacturer in this country expressed the same views; but he has since learned to be wise and to construct some of the best apparatus in the market. Another amusing feature in this discussion, and one to which we invite the attention of our own learned societies, is the following: "Mr. Moriarty, on being called upon, said he could not boast of much knowledge of the subject then under discussion, so he would, if agreeable, favour the company by singing the old English ballad, 'Sally in our Alley,' which he did." It goes without saying that such a joke could only have been perpetrated by an Irish member.

THE *Journal of Gas Lighting* has never been very favourable to electric lighting, but it seems to be awakening to the inevitable now, and notes the Kensington Court and other contemplated installations as "one of the signs of the times." It is a little ungenerous even now towards electricians and electrical journalists. It says: "An electrical journal falls foul of the *Morning Post* for publishing a mass of nonsense about the difficulty of adapting electric lighting to ordinary household use. . . . . It is rather hard upon the newspaper scribes, however, when the electricians, whose pretensions their ignorance has so materially helped in the past, turn round and abuse them now that times are harder." And so on. We contest these assertions. In the first place ignorant "newspaper scribes" have never yet benefitted the electrician. The promoter, the pretender and the charlatan have derived an immense amount of aid in their nefarious schemes from the daily newspapers; but the electrician and his representative journals have maintained an unvarying attitude of hostility towards these, and have sought by outspoken, honest criticism, to correct the errors of the too sanguine journalist of the daily press. They were not electricians who imposed upon the public, friend *Gas Lighting*.

OUR space is too limited this week to enable us to refer at any length to the letter of Mr. Callender. We must, however, disabuse his mind of the belief that we have any desire to even think unfairly of his company or of its manufactures. In a verbal explanation of the "phenomena" with which Leamington has been troubled Mr. Callender has impressed us with the belief — is not this also from hearsay evidence?— that the faults exist in a part of the plant quite distinct from the cables, and with which, we understand, the Messrs. Callender had nothing whatever to do. Whether this is so we hope will soon be conclusively shown. We are somewhat taken aback to be told so positively that the information we published was absolutely inaccurate in all particulars, although until the mystery has been solved we cannot see that Mr. Callender's letter proves his assertions, but we trust that it will explain away any misconception which may possibly have gained ground respecting the quality of his well and favourably known leads.

Modern Light and Heat is responsible for the following note, the utility of which it is difficult to see, unless our contemporary wishes to go so far as to employ permanent magnets. "Now that copper is dear, dynamo designers can remind us that 'magnetism is cheap.' More iron and less copper."

ELECTRIC WAVE AND PHASE INDICATOR FOR ALTERNATING AND UNDULATORY CURRENTS.

By ELIHU THOMSON.

THE purpose of the instruments designed by me and to be presently described is to enable us to study the shapes of the waves of alternating currents produced by different machines and apparatus, and also to study the relations of waves in different branches or portions of an alternating current circuit, so that the amount of lag or retardation of phase might be visibly noted.

The instruments to be presently described grew out of the use of cruder apparatus employing the manometric flame principle to study the undulations or vibrations of current. The manometric flame apparatus, which was made about a year ago, differed from that used in the study of sound waves in having an iron diaphragm instead of the flexible diaphragm which closes the gas space, and the movement of which in such apparatus, resulting from the impingement of sound waves thereon, gives rise to differences in the height of a flame jet fed by the gas, which differences or variations of height of flame were noted in a revolving mirror in the usual way. The iron diaphragm—of ferrotype metal—was placed in front of a bundle of iron wires around which and through a coil in the circuit to be tested the alternating currents passed. The results obtained with the manometric flame apparatus were only approximate and subject to a number of inconveniences common to such arrangements. It was found better to utilise the movements of the flexible diaphragm, carried through proper lever connections, to give a swinging or oscillatory motion to a small mirror, whereby a beam of light thrown upon the mirror and focused so as to produce a spot of light on a screen at some distance therefrom, might be caused to trace out the shape of the wave, and either the eye used directly to examine the wave-like image, or a sensitive plate employed for photographing or rendering it permanent.

The apparatus containing a single diaphragm and connections is shown in fig. 1. An iron wire core or

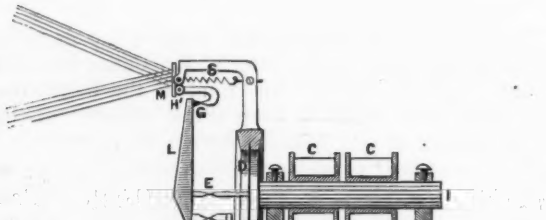


FIG. 1.

bundle, I, is mounted in a stand and arranged so that coils C, C, the number of convolutions of which may be made especially to suit the conditions of each experiment, may be placed upon the core. Sometimes these coils are made with multiple or parallel windings so that two or more sets of current waves may be caused to act upon the core, I, simultaneously. One of the coils or one of the windings may, when needed, be used to polarise or magnetise the core, I, with a definite strength of magnetism, as by a battery current or other continuous current. A diaphragm suitably mounted in front of one end of the core, I, and constructed of ferrotype iron follows closely the fluctuations of magnetism produced in the core by the currents in the coils. The distance of the core, I, from the diaphragm is made so that it can be adjusted. From the middle of the diaphragm a short aluminium wire, flattened out at E so as to be very flexible at that point and connected to a point on a very light but stiff aluminium lever, L, conveys the movements of the diaphragm to said lever. The lever, L, is constructed of flat metal and placed, as shown, so as to obtain the greatest stiffness with the least weight.

The fulcrum at F is composed of a flattened place in the metal wire, so that it has no lost motion. The connection of the long arm of the lever, G, has also a flattened place in the wire, and a delicate pivot, H, connects and conveys the movement of the lever, L, to the small circular mirror, M, mounted on a transverse axis and held down against the pivot so as to avoid lost motion, by a spring, S, attached to the middle of the back of the mirror and pulling on the same. The pivotal point, H, is put a little to one side of the axis on which the mirror swings.

Now, it will be evident by this construction that the slightest movement of the diaphragm, D, will be followed by a much magnified movement of the mirror, M, which mirror receiving a ray of light will, as it changes its position, cause such ray to spring over a considerable space on a screen at a distance of 18 or 20 inches away. The beam of light is obtained from a small illuminated pinhole reflected and focused upon the screen placed in front of the mirror at, say, a foot or 18 inches therefrom, and any movement of the mirror will, therefore, cause this small round spot to travel up and down in accordance with such movement.

If one of the coils of such an apparatus be traversed by alternating currents, and the whole apparatus be arranged to swing in a horizontal plane on a vertical axis or pivot at J just vertically under the mirror, M, the spot of light will trace out a curve which will approximate closely to the shape of the current wave, much depending on the perfection with which the apparatus has been constructed for the avoidance of much inertia by making the parts very light, and for the avoidance also of disturbing effects by having the diaphragm, D, traverse but a very small distance to and fro in front of the core, I.

As the core, I, is of soft iron, unmagnetised, both the negative and positive impulses of current produce movements of the diaphragm towards the core, one by developing north magnetism and the other by developing south magnetism at its extremity near the diaphragm. The alternating current will, therefore,

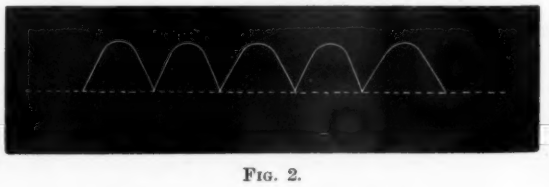


FIG. 2.

produce a wave line like that seen in fig. 2, in which the dotted line is the zero of current and the curve of the waves rising therefrom are produced by currents alternately in opposite directions. If, however, a continuous current be passed through one of the coils around the core, and the strength of this current gradually increased, the shape of the wave will undergo con-

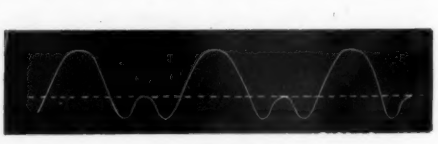


FIG. 3.

siderable alteration, and in one stage will be represented by the wave line, fig. 3, which represents the case of an alternating current passing at the same time with a continuous current in another coil, which continuous current is insufficient to so fully polarise the core, I, that the diaphragm, D, cannot be attracted by both im-

pulses. The small wave between the larger waves is an effect produced by the overpowering of the continuous current by the stronger opposite alternating impulses, while the larger waves are due to the combined attraction of the continuous current, and the alternating impulses which pass in the same direction around the core. If, however, as in fig. 4, the polar-

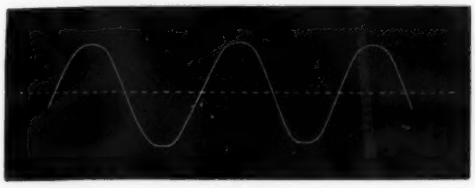


FIG. 4.

ising or continuous current be made slightly stronger, the wave, E, takes a shape in which the opposite impulses are represented by opposite movements, or in which the upper half of the wave line represents a current in one direction, and the lower half the flow of current in the other direction, except in so far as the shape may be modified by the action of the diaphragm itself. The actual appearance presented will be that shown in fig. 5, in which the curved line is on a black ground, the apparatus of course being enclosed in a dark box, with an opening opposite the screen for viewing the tracing of the spot of light.

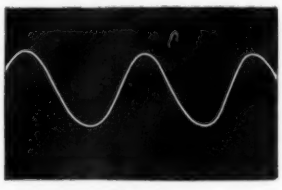


FIG. 5.

FIG. 6.

If no movement in a horizontal plane be given to the apparatus, the spot of light simply describes a vertical line, whose upper and lower extremities are much brighter than the middle, fig. 6, because of the stoppage of direction of motion which occurs in the spot of light at the upper and lower points of its swing, and of the fact that the highest velocity of traverse exists in the middle of the swing, or when the current is changing from positive to the negative, or the reverse. The appearance presented from figs. 2 to 6 inclusive are like those which were obtained from an alternating current machine the armature of which was without iron projections, such machine being one used in lighting by transformers. Fig 7 shows a wave line such as was produced by an alternating current dynamo having iron projections on the armature core. Here, it will be noticed, the curve is of irregular form, though regular in its irregularity. The curve indicates the sudden jumps of E.M.F. at the conclusion of each current wave, and this was undoubtedly due to the forcible pulling away of the armature projections from the field, causing, as a result, a far more rapid passage of magnetic lines across the armature conductors to the next succeeding projection, that is, the magnetism of the field on leaving one projection may be considered to swing quickly over to the succeeding projection irrespectively of the movement of the armature, and at the same time cut all the wire between the two projections and thus give rise to a jump or strong impulse of E.M.F.

Comparing the curves, figs. 5 and 7, it will be seen that the armature without projections has given a more perfect wave and that the induction is much smoother, no irregularities of E.M.F. showing themselves. Fig. 8 shows the appearance presented by the spot of light with the same current as in fig. 7, but with no lateral or horizontal movement given to the mirror. In this case, as in fig. 6, the spot shows a vertical image or bright line, but instead of the upper and lower extremities being the only points of the line which are bright, the line shows a tendency to the formation of bright spots at other points in its length, and these

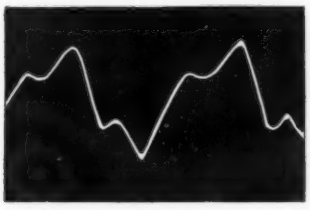


FIG 7.

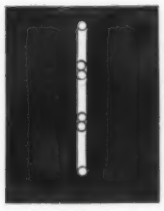


FIG. 8.

correspond with those positions in the wave at which the spot of light either hesitates or changes its direction of movement. In fact, the appearance, figs. 6 and 8, is as though the waves, figs. 5 and 7, were composed of a wavy band of light and were seen on end or in the plane of their propagation.

The apparatus with a single movement of the mirror, fig. 1, is not well adapted to the study of the relations of the positions of phase of two alternating currents, but by adding an additional core with its coils, and an

FIG. 9.

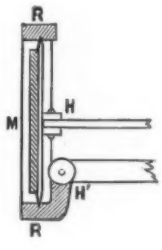


FIG. 10.

additional diaphragm and lever, and connecting the second set so as to impart a motion to the mirror at right angles to that given by the first set, the capabilities of the apparatus are much extended. The mirror for this purpose is mounted in gimbals, as in fig. 9, and a connection made from one lever which receives its motion from one of the diaphragms to the mirror, as in fig. 1, and from the other lever and diaphragm to the surrounding ring, R, fig. 10, by an

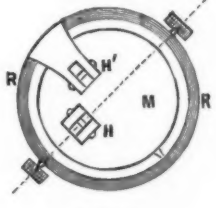


FIG. 11.

attachment, H'. Fig. 11 shows the back of the mirror, with the attachments, H, H', for the two levers. These attachments are preferably made at equal distances from the centre of the mirror so as to give the vibrations of the two diaphragms a nearly equal value in changing the position of the mirror. All of the moving parts are made as light as is consistent with proper rigidity.

Fig. 12 shows the arrangement of the diaphragms

and levers in giving movement to the mirror, M. Now, if the same current, or currents of exactly matched phases act to move both diaphragms, and the angular deviations of the mirror be balanced or equal, the mirror will cause the spot of light to travel in a straight line intermediate to the two combined movements given by the two levers. In this case, as shown in fig. 12, the spot of light will move in the direction of the vertical dotted line.

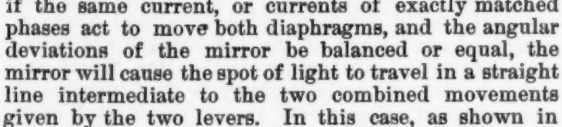


FIG. 12.

If, however, the phases of the alternations do not match, or one lags behind the other, the spot of light will describe an ellipse, one of whose axes will be more or less inclined from the vertical. In Fig. 13, Z is the screen, M the mirror receiving the double motion, K the source of light, and N a lens suitable to form on the screen, Z, an image of a small pinhole at Q. Further, if the condition be such that one of the

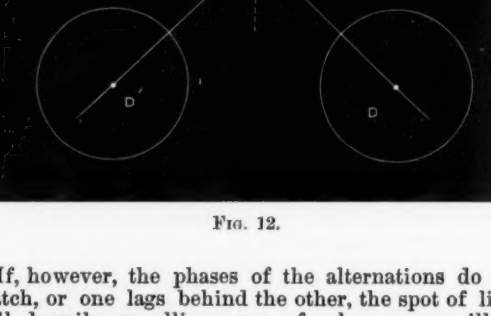


FIG. 13.

diaphragms be affected by a current whose retardation of phase is 90° behind that of the other, and the currents be of equal value in moving the mirror, a figure approaching a circle will be seen on the screen, which figure would be a perfect circle were the shapes of the waves perfect.

In actual trials with the apparatus it has been found that by combining the effects of alternating currents in circuits and branch circuits, a variety of figures, mostly ellipses, the relation of the length of whose axes varied greatly, and the inclination from the vertical of the axes of which also varied greatly, were produced. The changing position of the axes of the ellipses with respect to the vertical, if properly noted, gives an indication of the amount of angular lag or retardation of phase existing in one current as distinguished from the other.

It may be objected that the apparatus itself, on account of its inertia, must give rise to a retardation of record, but it will be seen that the two diaphragms, levers, &c., being substantially the same in character and dimensions, the inertia retardation will be practically a constant effect, and that any difference existing can be eliminated by exchanging the currents from one coil and diaphragm to the other so as to cause them to alternately affect the diaphragms, in which case the mean effect would be taken.

It is outside the purpose of this description to note all the uses to which this apparatus has been and may be applied. A few may, however, be mentioned. In fig. 14, G represents an alternating current generator feeding a primary line from which branches are taken off at intervals. T represents a transformer the load in the secondary circuit of which may be

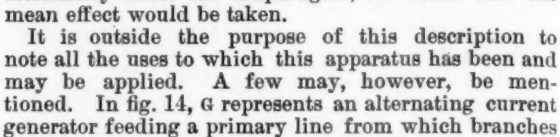


FIG. 14.

varied from nothing up to full work. The coil, C, affecting one diaphragm, is placed in the main circuit of the generator, and the coil, C, in the branch through the primary of the transformer affects the other diaphragm, the adjustments being made such that the vibratory effect of each, or the amplitude given to the wave movements of the spot of light by each, are equal. In an actual case of this kind it was found that the transformer under no load gave nearly a circle, and therefore showed that the currents passing through the primary had a lag or retardation of approximately 90°, or one quarter of a wave length, and this condition was departed from or modified by throwing on the load in the secondary. Time does not permit a full description of the actions, which were, however, very interesting.

Comparisons are also easily made with this apparatus between the positions of phases of the secondary currents and those of the primary currents in the transformer. By the use of a sufficiently bright light, as that of an arc lamp, and sensitive gelatine plates, the figures may of course be photographed.

The apparatus in either of its forms, single or double, may also be used as an indicator of the extent to which synchronism takes places in two alternating current machines or sources, or, again, it may be used to indicate the differences of shape of wave produced by such machines. In this case it is only necessary to use the apparatus of fig. 1, employing a double wound coil through which the currents from the two machines passes differentially, and produce equal amplitude of vibrations in the spot of light. This can be noted, and adjustment of the extent of the swing of the spot on the screen be made with each current separately.

The suggestion may here be made that having constructed as perfect a machine for generating alternating currents as possible, one in which the spacing of the waves during a revolution is exact, and the amplitudes of such waves the same throughout a revolution, and the form of the wave that which may be considered best in practice, it would be easily possible by coupling another machine to the first, so as to rotate in perfect harmony therewith, to note the divergences of form, of amplitude, and of position of waves in the two machines.

If the screen be replaced by a sensitive revolving plate which is geared to give exactly the same speed as that of the machines, when the machines are absolutely and perfectly matched, the spot should remain stationary and describe a circle on the plate around the centre of motion of the plate, but if the plate shows departures from this circular form, not only is a lack of harmony between the two waves or structures declared, but the positions of the departures from harmony are pointed

out by the positions of divergence from a circular path on the plate.

Whenever the wave produced by one machine is out of harmony, either in position of amplitude or shape with that of the other, the divergences will be indicated by the image on the plate showing a corresponding departure from a circle. The relative motions of the plate and machines being alike, the defects can at once be traced to their source. The movement of the spot upon the revolving plate in the case just referred to should, of course, be towards and from the centre of motion of the revolving plate.

Likewise with such an apparatus with a revolving plate, the current of a machine will, if the plate revolve with the armature, trace a wavy line returning into itself at every revolution, and it will be a record of the alternations or waves produced in every part of a revolution of the dynamo armature.

It will be evident that the curves obtained will only represent the true waves of current when the movement of the diaphragm is proportional, or nearly so, to the current in the coil around the core, I. The current at any time will produce magnetism in the core substantially proportional to the current at any instant, which magnetism induces opposite magnetism in the diaphragm, and the pull on the diaphragm would be nearly as the square of the current at any instant when the magnetism induced is far below saturation, so-called. The magnetic pull on the diaphragm is opposed by the elastic force of the same acting as a sort of compound spring against the pull upon it.

The nature of the effects will also vary somewhat with the distance from the diaphragm at which the core, I, may have been placed. Whether it will be possible to adjust all variations so that the movement of the spot of light may be in exact proportion to the current whereby the true waves may be obtained is now known.

It is to be understood that, in the use of such apparatus as has been described, the effects of the resistance and self-induction of the coils, C, traversed by the waves of current, should be so small as to have no considerable effect on the current, to ensure even moderate accuracy in the indications obtained.

ON THE DIFFERENCE OF PHASES OF CURRENTS, ON THE RETARDATION OF INDUCTION, AND ON THE DISSIPATION OF ENERGY IN TRANSFORMERS. EXPERIMENTAL AND THEORETICAL RESEARCHES.

By PROF. GALILEO FERRARIS.

THE object of the present memoir is the exposition and discussion of certain series of experiments executed by me in the electrotechnical laboratory of the Industrial Museum as far back as the end of the autumn of 1886. In these experiments I proposed to measure the difference of phase existing between the two alternative currents, primary and secondary of an induction transformer, to see how such difference of phase varies with the variations of the conditions of the work of the transformer, and especially with the variation of the resistance of the secondary circuit. A comparison of the first experimental results with the more simple provisions of the known elementary theory of induction transformers brought into evidence a notable discrepancy between the theoretical and the effective law; and the interpretation of this fact has served for a guide in the selection and the execution of the succeeding experiments. As the difference discovered between the relations demonstrated by experiment and those predicted by the elementary theory, are easily explained by admitting that the magnetisation and demagnetisation of the core of the transformer are effected with a certain retardation, and as this retardation must essentially depend on the structure of the core, I was led to institute comparisons by repeating the measurement several times, changing the core of the transformer each time.

The experiments showed that the theoretical relations which may be established when account is taken of the retardation in the variations of the magnetic polarisation of the core, and which are found if we consider the Foucault currents to which the above retardation is in part due, are in fact verified sufficiently well. And then the same relations become useful for the close analysis of the conditions on which depends the production of heat in the core and in the other metallic parts of the apparatus, and afford in this manner useful criteria as to the proportion existing between the energy capable of utilisation and that which is uselessly dissipated in the transformer.

SECTION 1.

Method for Measuring the Difference of Phase.

The author gives two methods for this purpose which cannot be explained without reproducing in detail the mathematical formulæ involved.

SECTION 2.

Arrangement of the Experiments and their first Results.

In order to apply the author's methods to the study of the differences of phase between the two currents of an induction transformer, it is necessary to introduce into the circuit the coils of the electro-dynamometers, the self-induction of which has an influence on the differences of phase which it is desired to measure. This observation may complicate the interpretation of the results of the experiment, and even in some cases might render it impossible if the object of the measurement were to determine what the transformer would yield alone without the addition of the coils of the rheometrical instruments, and when the special coefficients of induction of the electro-dynamometers would be of the same order of magnitude as those of the transformer.

But this difficulty does not exist in investigations like ours, the object of which is not to determine the constants of the transformer casually selected by experiment, but that of comparing the experimental laws of the transformer with those deduced from theory. For attaining this object it is absolutely indifferent whether we effect the measurement on the transformer selected or on a transformer slightly modified as to what results from the totality of the transformer properly so-called and of the coils of the electro-dynamometers introduced into the circuit. The only necessary condition is that the coefficients of induction existing in the circuits remain invariable during the whole of the experiments, a condition which is fully secured by the author's method of experimenting.

Besides, leaving out of the question the consideration of the object of the experiment, the difficulty abovementioned will be in the case of our measurements eliminated in the conditions in which they are effected. This was, in fact, done with a transformer of considerable power (2 horse) and with high coefficients of induction; and wishing to experiment with currents of great intensity such as those which are used in the practical applications of the transformer, no other electro-dynamometers could be used than the industrial ones of Siemens. Now, the coefficients of induction found in such instruments of measurement were several thousand volts smaller than those of the transformers, and to take them into account would be not only useless but impossible.

The secondary generator with which all the experiments here described were executed was of the Gaulard and Gibbs type: a model with a simple column of two horse power. The two spirals, the primary and secondary, were formed of flat layers of thin copper fashioned with a circular crown cut along a radius and joined together so as to form two curves. The spirals of one were alternate with those of the other, and they were insulated by means of leaves of paper coated with

paraffin. The iron core, which was cylindrical, was removable, and was changed for each series of experiments. The external diameter of the spirals was 114 millimetres; the internal 54 millimetres; the number of turns was 455 for each coil. The resistances were 0·276 ohm for the primary and 0·285 for the secondary. The secondary was formed of four equal parts, which could be connected either in series or in groups, or in derivation; but during the experiments they were always combined in series.

The primary currents were generated by a Siemens dynamo with alternating currents; the armature of which comprised eight coils united in series. Each revolution produced eight inversions of the current. The speed of the rotations was indicated continuously by a Buss tachymeter. A large industrial rheostat with copper wires served to regulate the intensity of the primary current. To introduce in single experiments the necessary resistances in the secondary circuit, there were used large coils of nickel silver wire, wrapped double and practically free from self-induction,

As instruments of measurement there were used, as already said, three electro-dynamometers for strong currents, constructed by Siemens and Halske, of Berlin. In these, as it is known, the fixed coil is made with few turns of wire, and the movable coil consists of a simple rectangular coil of a thick copper wire. Such a spiral suspended is brought back to the plane of rest, perpendicular to that of the fixed coil, by means of the torsion of a spiral spring, and the measurement is made by reading off the angle of torsion. The coefficients of self-induction of the instruments described were insensible in comparison with the exceedingly high ones of the secondary generator, the movable coil being always in a plane perpendicular to the fixed coil, there could be no question of mutual induction.

The three electro-dynamometers being placed in the position where they were to be during all the experiments, they were combined in series and inserted in the secondary circuit of the secondary generator for the preliminary comparison. With the rheostat of copper wire placed in the primary circuit, and with the resistances inserted in the secondary circuit, the intensity of the current in the electro-dynamometers was made to pass through all the series of values which would occur in the actual experiments. There was thus made a series of simultaneous readings, α_0, γ_0, β_0, from which the constancy of the ratios $\frac{\beta_0}{\alpha_0}$, $\frac{\beta_0}{\gamma_0}$ might be ascertained and their mean values determined by introducing them into the formulæ

$$\frac{a}{b} = \frac{\beta_0}{\alpha_0}\frac{\alpha}{\beta}, \quad \frac{c}{b} = \frac{\beta_0}{\gamma_0}\frac{\gamma}{\beta}.$$

In this manner there was found

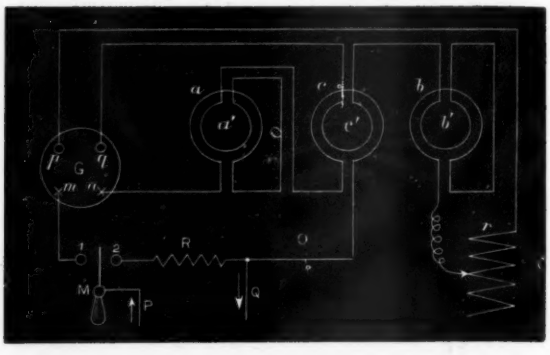
$$\frac{a}{b} = 1{\cdot}0274\,\frac{\alpha}{\beta}. \quad \frac{c}{b} = 1{\cdot}0475\,\frac{\gamma}{\beta}.$$

These determinations were several times repeated during the successive series of experiments, and at the end of all.

After these comparative experiments there was insulated, in the second electro-dynamometer on which the reading of γ was to be made, the spiral suspended from the fixed coil, and the two extremities of each are joined to the opposite pieces.

The instruments being thus prepared, the secondary generator, the nickel silver spirals, and the primary circuit were confined as shown in the accompanying figure.

Here G represents the secondary generator, and in which the two crosses, m, n, indicate the terminal pieces of the secondary coil; a, a', c, c', and b, b', represent the three electro-dynamometers destined respectively for reading off the values which we have above indicated by the letters α, β, γ; the external circles, a, c, b, represent the fixed coils, and a', c', b', those which are movable. The coils deprived of self-induction, and destined for introducing resistances into the secondary circuit of the transformer, are represented at r; R represents a resistance approximately equal to the apparent complete resistance of the primary coils, m, n, of a, of a', and of c. Lastly, M is a lever commutator for inserting into the circuit, P, Q, of the dynamo, the secondary generator, and the instruments of measurement.



When the lever of the commutator is in contact with the piece 1, the primary current which arrives from P passes into the primary coils, m, n, of the transformer into the fixed coil, a, and the movable coil, a', of the first electro-dynamometer and the fixed coil, c, of the second; it returns to the dynamo by way of Q. Meanwhile, the secondary coil, p, q, is in a closed circuit comprising the movable coil, c', of the second electro-dynamometer, the movable coil, b', and the fixed coil, b, of the third electro-dynamometer and the resistance, r. When instead of the commutator the contact is established with the piece 2, the transformer and the instruments of measurement are all in the circuit, and the circuit of the dynamo is closed by the equivalent resistance, R. Another interrupter attached to the great copper wire rheostat serves to break or to close the circuit of the dynamo, but this is not represented in the figure.

In the following table are given the results of a first series of experiments made with the arrangement described :—

No.	n.	r.	α.	γ.	β.	$\frac{a}{b}$	$\frac{c}{b}$	ϕ.
1	603	0·409	126·2	121·9	126·4	1·026	1·010	175° 30′
2	606	1·953	129·6	118·3	119·2	1·117	1·039	169° 26′
3	605	3·224	99·8	84·9	84·4	1·215	1·054	162° 59′
4	600	4·462	118·9	91·9	89·6	1·363	1·074	156° 55′
5	601	5·713	82·8	56·3	54·5	1·561	1·082	150° 0′
6	607	6·958	116·5	70·3	67·1	1·784	1·097	145° 13′
7	609	8·542	93·1	47·0	44·4	2·152	1·109	139° 7′
8	601	9·760	102·5	44·4	41·0	2·569	1·134	135° 2′
9	610	11·000	87·9	33·7	30·9	2·923	1·142	131° 55′
10	606	12·240	98·8	32·4	29·2	3·476	1·162	128° 33′
11	602	13·470	97·6	26·3	23·6	4·249	1·167	124° 29′
12	602	14·790	104·0	24·7	21·6	4·969	1·203	122° 40′

In the first column of this table is given the successive number of the experiment; in the second, the number, n, of rotations made by the dynamo per minute; in the third, the total resistance, r, of the secondary circuit of the transformer. In the three following columns are registered the readings of α, γ, β; then follow the values of $\frac{a}{b}$ and $\frac{c}{b}$ calculated from the same readings, and in the last column the angular values, ϕ, of the difference of phase calculated according to the formula.

$$\cos.\,\phi = \frac{c}{b}\,\frac{1}{\sqrt{\frac{a}{b}}}$$

To interpret these results, it is necessary that we com-

pare them with those to which we are led by the elementary theory of the transformer, in which theory neither the currents of Foucault nor the retardation in magnetisation and demagnetisation are taken into account. It will be useful here to record briefly some points of this theory.

(*To be continued.*)

CROMPTON AND SWINBURNE'S IMPROVEMENTS IN DYNAMO-ELECTRIC MACHINERY.

In a dynamo, as at present usually constructed, a large proportion of the magnetising force due to the wire on the field magnets is spent in overcoming the air resistance between the poles of the field magnets and the armature. This air space has been generally necessary to allow the armature wire to be wound on. Where it has been reduced by using projections, as, for instance, in the Pacinotti ring, heating of the field magnet poles is caused, but by Messrs. Crompton and Swinburne's improvements dynamo machines may be made which have a very small clearance between the armature and field-magnet poles, so that a very small magnetising force on the field magnets is sufficient to magnetise the armature nearly to saturation.

Take, for instance, the case of a ring, or, as it is sometimes called, a cylinder armature, such as that used in the well known Crompton dynamo. A space is here arranged between the outside of the armature and the pole pieces to admit of the requisite amount of wire being wound on. According to the improvements, the wire is not wound on the outside of the armature, but passes through holes which are punched through the discs near the outer edges. Only enough clearance is then allowed for the armature to turn freely. These holes in the discs are punched at such distances apart that there is enough iron between them to admit of the induction due to the field magnets. In small machines they may be made round for convenience in drilling or punching, but in larger machines they are preferably made rectangular or with their sides radial, or nearly radial. The iron left outside these holes is thick enough to make the field between the field magnets and the armature practically uniform, so that no Foucault currents are generated in the pole pieces; but it is at the same time kept thin enough not to waste too much induction round the sides of the armature, because the induction round this part of the armature is wasted as far as producing electromotive force

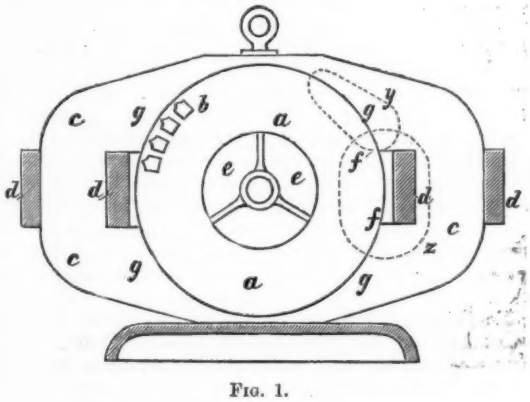


Fig. 1.

is concerned. If instead of holes grooves were used, the armature would resemble the Pacinotti form, and Foucault currents would be produced in the poles; the surface of iron exposed to the fields would also be less, which is of some consequence, as there must always be some clearance, so that there must always be some magnetising force spent on the air space.

Fig. 1 is a diagrammatic view of a direct current dynamo according to Messrs. Crompton and Swinburne's improvements. *a*, *a*, is the armature, built up of discs in the usual way. *b*, *b*, are holes for the active wire. A few only are shown. The wire is wound through the spaces, *e*, *e*, if the armature is wound as in a Gramme machine, or over the ends if the drum winding is used. *c*, *c*, are the field magnets, and *d*, *d*, the field magnet coils wound round the field magnets. It will be obvious that the whole machine is very much lighter than those generally constructed, because the field magnets are so small in proportion to the armature. The machine is also more efficient, because less power is spent on the field excitation. The ampère turns on each field magnet should be greater than the ampère turns on the part of the armature included between the points, *f*, *f*, by an amount which will more than produce the necessary induction when there is no armature current. If the corners of the pole pieces, *f*, *f*, are brought closer together, the ampère turns needed will be less, but this leads to difficulties in construction.

The machine here shown has what are known as double magnets. Single magnets might have been used, but they would have been much heavier, and the machine would be more liable to spark. The saving in power spent in the field magnets would have been very small. Instead of winding the wire round the field magnets it might have been wound round the armature, but, unless the armature is very long, there is no saving in doing so.

The pole pieces, *g*, *g*, are made just large enough not to be saturated by the induction due to the field magnets, and they are thinned down as shown to reduce the cross induction as much as possible, otherwise the lead of the brushes would be excessive or the machine would spark. For the same reason the area of iron between the holes is so proportioned that that part of the magnetic circuit is saturated first by the fields. The inventors call the induction due to the armature current round such circuits as that shown dotted at *y* the cross induction. The induction due to the armature current which opposes the field induction, and with an unexcited field would be round such a circuit as that shown dotted at *z*, interlinked with the field wire, they call the back induction.

Theoretical investigations of the action of the armature currents in machines have led Messrs. Crompton and Swinburne to the conclusion that such means as those just described will not be quite effective in large machines, as the difficulties are much increased by the absence of the air space. The results of their investigations are embodied in another patent, but they apply to this form of machine as well as to others. In fig. 2 is shown what they call reversing pole pieces, *h*, *h*. These

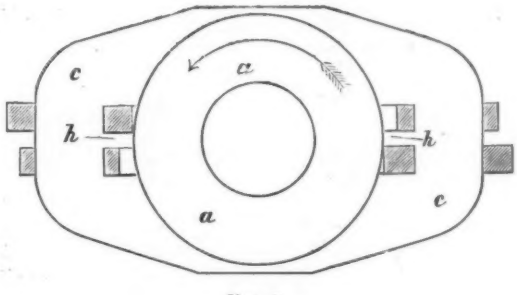


Fig. 2.

are so arranged that in spite of the action of the armature current, they produce a field which reverses the current in the sections of wire short-circuited under them by the brushes. The reversing pole pieces, *h*, *h*, may have coils wound round them, or they may have the field coils wound more on one side of them than the other, as shown in the figure. The excitation of the field is less in this form of machine, as there is no back induction. The arrow in fig. 2 shows the direction of rotation of the armature as a dynamo. As a

motor it runs in the opposite direction, or else the large and small magnets coils are exchanged.

Fig. 3 shows a machine with no magnet coils proper. The brushes are given a negative lead so as to be under the reversing pole pieces shown at *h*, *h*. These pole pieces are wound with coils of wire, *i*, *i*. The arrow

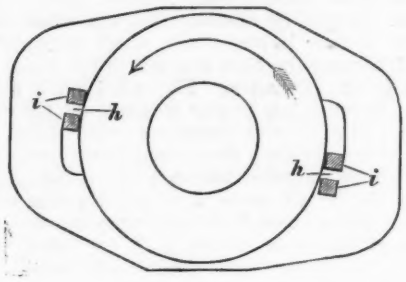


FIG. 3.

shows the direction of rotation as a dynamo, as a motor it is reversed. This is most suitable for large machines.

Fig. 4 shows a four-pole machine. There are two polar faces to each pole piece, and they are made substantially as shown, so that there may be little cross-induction and little lead of the brushes. A 4-pole

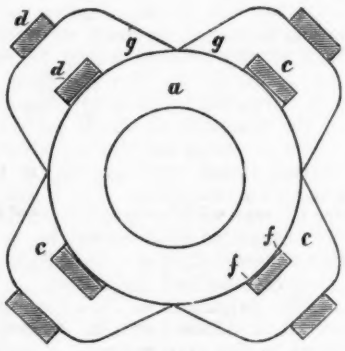


FIG. 4.

machine might, of course, be made with two magnets only, each of the horse shoes being wound with one coil of wire, but as 4-pole machines are used when lightness or large outputs are desired, such an arrangement would be bad.

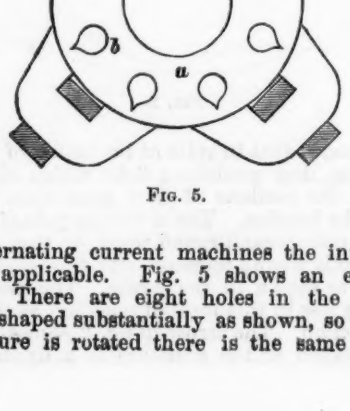


FIG. 5.

For alternating current machines the invention is specially applicable. Fig. 5 shows an eight pole machine. There are eight holes in the armature. These are shaped substantially as shown, so that when the armature is rotated there is the same induction through the field magnets whatever the position of the armature holes.

This overcomes one of the chief difficulties in alternating current machines, as it admits of iron in the armature without heating of the field magnets. Instead of *a*, *a* being the armature, that is to say, the part wound with wire in which the alternating current is generated the parts shown as field magnets may be used. The field magnets are then rotated inside the armature. The parts, *c*, *c*, should then be laminated. The field magnets or rotating part may be made of a solid piece of wrought or even cast iron.

There is difficulty in starting alternating current motors as at present constructed. To overcome this difficulty the inventors laminate both the armature and field magnets. The armature is provided with a commutator, as if it were intended to give intermittent direct currents when excited separately as a dynamo. Thus an eight pole machine such as that shown in fig. 4 has the two ends of its armature circuit connected to eight sections, of which four are connected to each end.

A NEW SYSTEM OF UNDERGROUND ELECTRICAL CONDUCTORS.

By D. BROOKS.

As early as 1877 I laid some wires experimentally in West Philadelphia, using rosin mixed with paraffin oil in the terminals or that portion above ground. Three years since I used rosin and rosin oil mixed in the terminals of the cable I laid for the Metropolitan Telegraph and Telephone Company in New York. There were probably twenty of these terminals coming out of the ground and going up by the side of the poles, say 50 or 60 feet, and there the wires were distributed, or as the common expression is "fan out." In order to get this mixture into the iron pipe, we first ran through a quantity of hot oil to sufficiently heat the pipe to keep the mixture fluid that followed until it had gone the full length of the pipe, or, in other words, filled the pipe.

Something over a year since, 500 feet of lead encased cable insulated with rosin and rosin oil was sent to the English Post Office Department for experimental purposes. Mr. Preece, the government electrician, refers to it in the *Journal of Telegraph Engineers and Electricians*, No. 67, Vol. 16, May 26th, 1887, page 429, in the following words:

"It has a most remarkably high insulation. Some samples that Mr. Kempe tested a short time ago gave a result of 19,000 megohms per mile, which was so high that I had some doubts of its permanence. The first test was made in the early part of the year; last week Mr. Kempe tested it again, and again the same material gave exactly 19,000 megohms per mile. Well, I think, when we get materials with such a high insulation as that, with sure indications of its permanence, there is some hope that we have something that will make us independent of fraudulent gutta-percha."

This excellent insulating quality has for years made itself manifest, and caused me to endeavour to make use of it in iron pipes instead of lead, iron being so much cheaper, more stable, and in every way preferable.

To this end Patent No. 356,981, February 1st, 1887, was taken out (English patent of same date), and the first work under that process has lately been completed on the Pennsylvania Railroad from Broad Street Station to the station at Thirty-second and Market Streets, Philadelphia, a distance of one and one-third miles.

It should be borne in mind that this cable has 18 splices, and that it is impossible or exceedingly difficult for the insulation of a splice to be made equal to the balance of the line. The German Government allows the insulation of a splice to equal that of three miles of the line, and according to their calculation we should allow 54 miles to be added to the length of these

conductors as an allowance for splicing; if we do this, the figure for insulation is much higher than that given by Mr. Preece. The following are the tests made by three different parties:

FIRST.—BY DR. CRESSON.

Bureau of Experiment and Chemical Laboratory,
No. 413, Locust Street, Philadelphia.

Test of Brooks's cable at Broad Street Station, Philadelphia, December 11th, 1887. Thermometer 59° F.
Insulating material, rosin and rosin oil.
Length of cable, one and one-third miles.
Number of conductors in the cable, 53.
Gauge of conductors No. 1, or core wire No. 18, balance No. 16.
Test made on four conductors, the other 49 being grounded at both terminals.

Insulation Test.

Number of cells of battery, 100.
29,500 divisions on the scale.
Constant per megohm = 2,950 divisions.
Deflection after one minute electrification.
No. 1 conductor, 18 gauge, 18 joints. No deflection.
" 2 " 16 " " " " "
" 3 " 16 " " " 2¼ "
" 4 " 16 " " " No deflection.
Nos. 1, 2, 3 and 4 bunched or connected as on wire deflection = 8.
Total insulation = 369 megohms on 5 and one-third miles of wire = 1,968 megohms per mile, 18 joints in each conductor = 72 joints, and allowing 3 miles per joint = 77 and one-third miles of wire = 30,763 megohms insulation per mile.

Electrostatic Capacity.

By Elliott standard condenser.

Cable Deflections.

	Charge.	Discharge.
No. 1,	1,300	1,300
No. 2,	1,750	1,800
No. 3,	1,700	1,750
No. 4,	1,750	1,750

Note charge and discharge are nearly the same indicating high insulation.
Comparison of cables and condenser by discharge:—
No. 1 = ·157 mfds. per mile.
" 2 = ·218 " "
" 3 = 212 " "
" 4 = 212 " "

CHARLES M. CRESSON, M.D.

SECOND.—BY CARL HERING.

Philadelphia, December 8th, 1887.

Mr. David Brooks.

Dear Sir,—At your request I have this day made a test of your cable of wires, leading from the Broad Street Station of the Pennsylvania Railroad in this city, to Powelton Avenue Station, a distance which you say is about one and one-third miles, the cable consisting of 53 wires.

The constant of the Thomson unshunted galvanometer was found to be 1,750° per megohm. When only one wire was measured for insulation, the deflection was not perceptible; all of the 53 wires were therefore connected together and the deflection found to be only 11°, the zinc pole being to ground. The insulation resistance was therefore 159 megohms for 53 wires of one and one-third miles each. This gives the remarkably high insulation resistance of 11,200 megohms per mile of wire.

The capacity was then measured, first with four wires charged and the other 49 disconnected, and second with the other 49 wires grounded. The constant of the galvanometer for one microfarad was found to be 4,800°. The discharge of the four wires in the first case gave 1,800°, which therefore shows a capacity of ·071 microfarads per mile of a single wire. In the second case, when the other wires were all grounded, the deflection was 4,800°, thus giving ·188 microfarads per mile of single wire.

The weather was clear and dry, the temperature being moderately warm.

I am pleased to be able to certify to the correctness of these figures, as they are so remarkably good that I should have been inclined to mistrust them had I not been able to satisfy myself of their correctness.—Yours very truly,

CARL HERING.

THIRD.—By F. W. GRIFFIN.

Philadelphia, November 30th, 1887.

David Brooks, Esq., Phila.

My Dear Sir,—I beg to say to you that I to-day tested the wires you have recently laid between the Broad Street Station of the Pennsylvania Railroad Company and their telegraph office at 32nd and Market Streets, one and one-third miles distance, with the following result:

Constant of galv. through 1,000,000 (one megohm) with 100 cells of battery, 1,100 divisions. We first tried one, two, three, and four wires singly, and got no readable deflection; we then attached the lead wire to the four wires combined, still obtained no readable deflection. We then grounded all the remaining wires (49) and still obtained no sensible deflection, but calling it one division for the four conductors would give an insulation per mile of 5,833 megohms.

We next tested the wires for electrostatic capacity: No. 1, with all the other wires grounded, showed a capacity of 0·14 per mile, gauge of wire No. 18, American.

No. 2, with all other wires grounded, showed 0·18 per mile, gauge No. 16.

No. 1, with the grounds taken off of other wires, showed 0·10 per mile.

No. 2, with the ground taken off of all other wires, showed 0·13 per mile.

Temperature above ground 35°; underground, 60°.

Two-thirds of the pipe is hung under the tract of elevated road. The balance is laid beneath the ditch in West Philadelphia.

I beg to congratulate you on the remarkable showing in this test, which I believe is the first experiment with your process, patented on February 1st, 1887.

These tests were made in the presence of Mr. Fowle, of the Pennsylvania Railroad Company, and Mr. John K. Butler, of the American Telephone and Telegraph Company.—Yours truly,

F. W. GRIFFIN.

The following letters refer to the durability of the insulating material.

In my opinion, the compound of rosin and rosin oil which Mr. Brooks uses as an insulating material, when enclosed in a tube, or otherwise protected from the action of the air, is practically unchangeable as to the characteristics upon which its insulating power depends.

CHARLES M. CRESSON, M.D.

Philadelphia, December 3rd, 1887.

David Brooks, Esq.

Dear Sir,—In answer to your inquiry in regard to the quality of rosin oil after a period of time, I beg to state that after a long experience in making rosin oil, I find that the quality is much improved by age. Either in bottles, barrels, or vessels of any kind, the oil becomes richer and softer, similar to most other distilled liquids.—Yours truly,

EDW. H. ROWLEY,
of Edw. H. Rowley & Son, Distillers of Rosin Oil.

P.S..—It becomes less liquid in low temperatures, but never congeals or becomes solid.

New York, December 3rd, 1887.

Mr. David Brooks, Philadelphia, Pa.

Dear Sir,—Replying to your favour 2nd inst., inquiring "whether our 'London oil' undergoes any change in barrels, or any other vessel, corked or sealed, except to be less fluid in cold weather, or low temperature, and also how long it will last without undergoing any change," I beg to inform you the "London oil" will not deteriorate on account of time, and holds its adhesive properties and gravity for years without any change, except in cold weather, when it becomes much thicker; otherwise the quality of the oil remains the same.—Yours truly,

JOHN A. CASEY.

It will be observed that a No. 16 gauge wire has about 40 per cent. greater electrostatic capacity than a wire of No. 18 gauge, but the surface of the No. 16 is only 27 per cent. greater. A 30-conductor cable of the same No. 18 gauge, with one winding for each wire, insulated with oil, gave ·4 for capacity, but as this No. 18 has two windings, and all the other wires two windings, it appears that the electrostatic capacity is a little more than one-third of the amount, when but one winding is used upon each wire. Again, if all the other wires in the cable had been No. 18 gauge, the electrostatic capacity of No. 1 would have been still less, or something in the neighbourhood of one-third of what it would have been if each wire had but one winding of cotton. Now, suppose we put on four windings or two windings of double thickness each, and use No. 18 American gauge for a conductor, then we would reduce the electrostatic capacity to something like ·07; quite probably less. Electrostatic capacity is directly in proportion to the extent of the surfaces of the conductors and in inverse ratio to their distances from each other. In practice it appears that when it should be one-fourth, according to the laws of electrostatics, it is really only one-sixth or less.

The conductors in a gutta-percha or India-rubber cable suspended in the air are much more affected by inductive disturbance than when the same cable is drawn into a lead or iron pipe. The reason of this is that the inductive effects are distributed, a large portion are divided between the pipe and other conductors;

and the same applies to wires strung upon poles, although they are thousands of times further separated than when grouped into a cable. The inductive effects are not decreased in that proportion simply because there is no other conductor besides the wires to receive its effects. When the conductors are in a metal pipe, which may be further away from them than the average of the other conductors, the pipe receives a very large portion of the disturbing effects on account of its greater size and surface, and it is quite probable that when the pipe is buried in the earth, the earth itself would tend to increase the tendency of the pipe to diminish the disturbing annoyance upon the other wires.

Some of the European electricians contend that the resistance of a conductor, when multiplied by its electrostatic capacity, gives a product which is a direct measure of retardation. It is a more direct measure of the capacity of the conductor to develop disturbing elements such as cross talk and disagreeable rattling.

The difference in conductivity between a conductor of No. 14 gauge in a length of line say of 10 miles, and that of a No. 20 gauge when used for telephone purposes, is not appreciable by any means that I can suggest. By placing one of the telephone receivers near a clock at Broad Street Station, and using the No. 18 gauge conductor with another telephone a mile and one-third distant in West Philadelphia, the tick of the clock is distinctly heard in West Philadelphia; substituting the entire 53 conductors, the person listening cannot distinguish any increased sound in the telephone receiver, although the conductor in the latter case has at least 75 times less resistance. In this experiment of using one wire for a conductor and the entire 53 in comparison, the iron pipe was used for the return circuit, and no rattling disturbance was observed in either case.

To make a telephone circuit as free as possible from inductive disturbance, we should separate the wires as far as possible. If we reduce the circumference of the conductors one-half, we reduce the disturbance by one-half; if we double their distances from each other, we still further reduce another half or to one-quarter of its original amount; and if we can by these means reduce the electrostatic capacity to one-tenth, we reduce the disturbing elements to one-tenth and proportionately increase the distance to which the conductor can be worked without annoying disturbances.

The resistance of a No. 18 wire, American gauge, for 10 miles is about 350 megohms. The resistance of 200 miles of No. 18, American gauge, is about 7,000 megohms; the latter figure is something in the neighbourhood of the resistance of the metallic circuit as employed between Philadelphia and New York. It is 20 times greater than 10 miles; yet the telephones work well, showing that low resistance in telephone circuits is not essential. The operators of the Long Distance Telephone Company say they cannot distinguish any advantage in the use of No. 12 gauge over that of No. 18 in working the metallic circuits between Philadelphia and New York. If so, it is certain there is little to be gained in using a larger conductor than No. 20 on circuits not exceeding 10 miles in length, but, as before stated, there is an advantage in an electrostatic or inductive sense.

THE ADVANTAGES OF IRON OVER LEAD.

An iron pipe two inches in diameter costs no more per foot than a lead pipe one inch in diameter. The capacity of the iron pipe is four times that of the lead pipe, and consequently can contain four times as many conductors of equal gauge and insulation. Now, suppose we put 100 wires of equal gauge in the lead pipe and 100 in the iron pipe, the latter insulated to four times the thickness; it follows that we can work the wires in the iron pipe with one-quarter the inductive disturbance that would exist provided the lead pipe was used. Alfred F. Moore quotes a 100 wire cable, No. 20 gauge, one winding for each wire, at 21 cents per foot, with four windings at 29 cents per foot. The latter cable has less than one-fourth the inductive disturbance of the former, but you can put a cable containing 400 wires in the iron pipe if it is desirable and have them work as well as the 100 wires in the lead pipe.

The greater strength of iron over lead makes it preferable in making the cable secure from injury.

Splicing of the conductors is much more readily performed. There is abundance of room in the splice boxes for splicing, and no soldering is needed.

ELECTRIC LIGHTING.

Fig. 1 shows a splice box 12 inches inside diameter. Fig. 2 shows the lid which screws on over the box. In the centre of the lid is a hole one inch in diameter closed by a screw plug. Through this opening the melted insulating material is introduced. The side outlets are made to fit a three-and-a-half inch diameter pipe, but can be adapted to pipes of smaller diameter by the use of a bushing as shown on the lateral sides of fig. 1, where two wires are brought out to bring lamps into service. The capacity of a three-and-a-half inch pipe is sufficient for 40 No. 4 gauge electric light conductors. Moore quotes a strand conductor equal to No. 4 at 4 cents per foot. For that kind of a conductor encased in lead one of the electric light companies of this city shows bills where it pays nine and four-tenth cents per foot. At that rate, 40 conductors encased in lead would cost $3.76, while the copper alone costs $1.60, showing the lead itself to cost $2.16 for the 40 feet. The Allison Manufacturing Company quotes three-and-a-half-inch pipe at 32 cents per foot, showing a saving of $1.84 cents per foot where iron is used instead of lead. Sixty conductors are as many as are now used by any single plant in this city, but where the number exceeds 40, two pipes could be laid; but this number diminishes as you leave the station where the power is applied to the dynamos. Where a smaller number of conductors is employed, a pipe of less diameter can be used with diminished cost per foot of pipe. But there are other circumstances which reduce the cost. The entire group of conductors can be drawn into the iron pipe by one operation, whereas there has to be an operation of that nature for each conductor when lead is used.

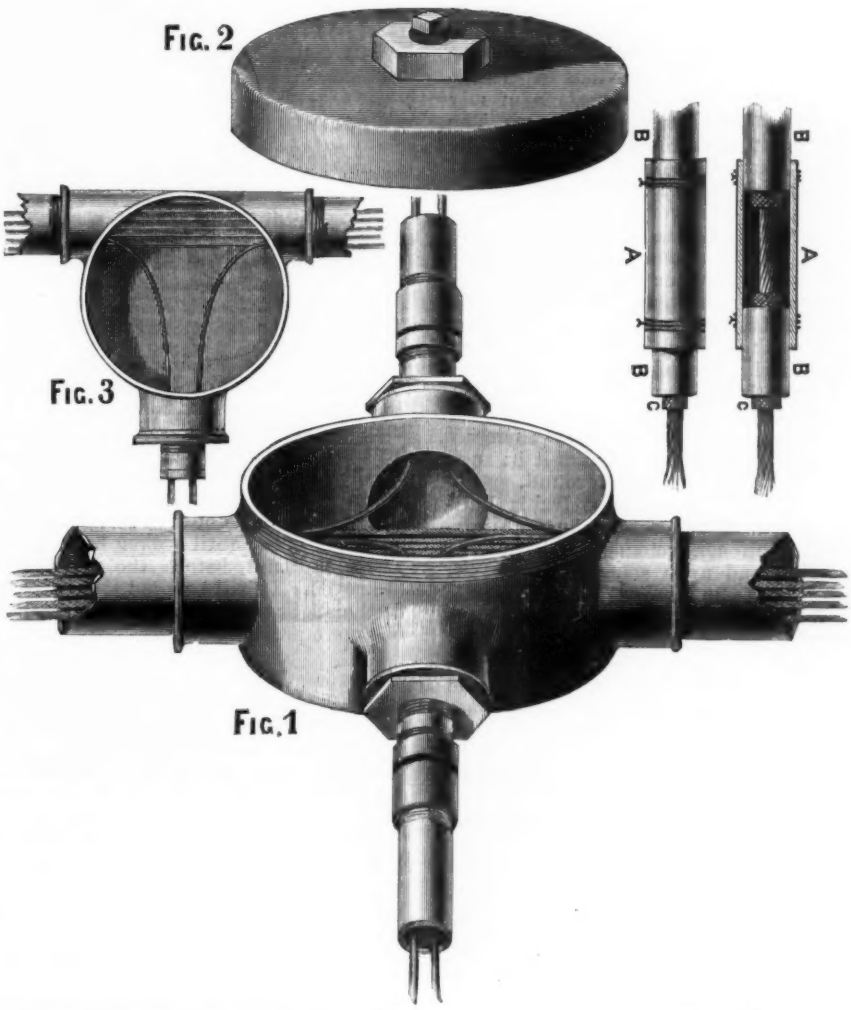
There has been considerable work done in this city within the past few months in laying electrical conductors for incandescent electrical lighting. The conductors were drawn into each length, of about 20 feet, of pipe, and the pipe then filled with insulating material in the factory, from which it was transported to the place where it was buried in the ground, and the conductors spliced in a cast-iron box at the end of each length of pipe. This system of splicing makes the work tedious and expensive, certainly so much solder in the joints is of no benefit to the conductivity of the conductor, nor is a splice or joint in the insulation anything but detrimental to the insulation.

In this system a hand hole or splice box is only necessary say for every three lengths of pipe to reach every building in the street, and a thousand feet of the conductors can be drawn in at the one operation. It can be readily seen there is an immense margin for economy.

For arc lighting this system has special advantages where currents of so high potential are employed. The insulation itself is specifically higher than anything else known. Wherever there is a fault in ordinary insulation, the tendency of the current is to centre in that fault and increase the defect by the action of the current until the fault developes into perfect earth (see "Culley on the Treatment of Underground Conductors," page 332, 8th edition), but with this system a different state of affairs exists. As soon as any portion of the insulation becomes weak, or conducts, the current itself produces heat, and the insulation which is semi-liquid expands and moves away, producing a circulation, and a cooler insulation takes its place. When a wire becomes hot or incandescent in the air, it sets the air in motion but it does not burn the air; if it is in water, it vapourises the water and sets that in motion, and a cooler current of water takes its place.

It will be observed, by reference to fig. 1, how a loop

is brought into the splice box by means of a running screw and a short piece of inch pipe filled with cement. The wires for this loop are lead encased, and when brought to a lamp or instrument, have the terminals insulated by cutting out a piece of the lead covering and insulation as shown in fig. "A," where a section of lead covering and insulation is removed, and over this space is drawn two or three inches of soft rubber tubing, and bound tightly with twine at each end as shown in the cut. It will be seen that if the insulation letter "C" becomes sufficiently damp to carry a current from the conductor to the lead covering "B" that it can go no further than the rubber sleeves, otherwise, the current would go to the earth. I notice some one evidently interested in other kinds of insulation, writes in one of the English journals that the tendency of the current to pass from the conductor to the lead is "fatal" to the use of lead encased conductors. All the wires lately laid for the Pennsylvania Railroad are provided with this device, and when we remove any of the wires from the lightning arrester and charge them, they do not fall to one-half their charge in less than an hour. I do not see anything "fatal" in that. Messrs. Tatham and Bros. of this city have a patent for this device. When this attachment becomes impaired from long exposure to the weather, it can be readily removed and replaced by a fresh piece of rubber tubing. Fig. 3 shows a modification of the hand hole placed at one side of the pipe in order that another pipe can be placed at the side of the pipe entering this box, and by that means when there are a number of pipes in the same box they do not have to be spread apart to make room for the hand hole. This becomes useful when two or more pipes are laid in the same box filled with pitch. For an ordinary telephone or telegraph cable, 1,000 feet can be easily drawn into an iron pipe which has been made perfectly smooth inside by a process of scouring. For house to house electric light work these splice boxes, or more properly hand holes, are employed as often as one for every two buildings. The same applies for telephone purposes. Eighteen inches depth is sufficient for the trench. The pipe is enclosed in a wooden trough of sufficient dimensions to admit the pipe sockets, which are something larger than the pipe, leaving sufficient space for pouring in melted pitch, which effectually protects the iron from oxidation. The wooden box is of such small diameter that all the earth taken from the trench can be replaced, and no hauling away of earth is required, which is no small item in construction. In this system no manholes are required; they would be worse than useless. These splice boxes are made of malleable cast iron, and can be reached by removing the paving stones over them as readily as those heavy cast iron covers to the manholes, especially in winter time when they are fastened in their position by ice. These manholes are receptacles for filth, and are prejudicial to health, and continually liable to explosion from gas collecting therein. Wood troughs or boxes were once used in London, but have been entirely abandoned on account of being subject to dry rot and a source of danger from accumulation of gas. (See Mr. Fleetwood's Report, May 26th, 1887, *Journal of Society of Telegraph Engineers and Electricians*, Vol. 16, page 413.) By this system five hundred telephone or telegraph wires can be drawn into a three inch pipe, and the pipe can be warped either above or below, to the right or to the left of any obstruction you



meet, and if you give the pipe a bend of a two feet radius it can be drawn around a corner at right angles. Ordinary conduits have to be laid straight. I am not posted as to their expense, but I know sufficient to affirm that I can lay by this system more conductors of equal size and better insulation than can be drawn into the conduits for less money than the conduits cost without any wires in them. I will lay those on one side of the conduit itself. Another view of the case; I will take the other side of the conduit and lay more wires than they can get into their conduit, wires of equal conductivity and better insulation for less money than they can put them into their conduit after it is laid.

A conduit, of all things in the world, is the worst place to put wires except a fire itself, they are filled with ammoniacal gases from the sewers, and gas from the street mains so combined with moisture that disintegration and decay attacks anything that is put in them.

This system laid for the Pennsylvania Railroad was done by men who never had any previous experience in underground work for electrical purposes of any kind. I have not the entire items of expense. The pipe cost fourteen and one-half cents per foot, the cable cost 20 cents per foot, but I am told by the engineer in charge that the cost of that portion west of the Schuylkill River completed in every way, cost less than that number of iron wires of equal conductivity upon poles, of which the company has ample experience. The portion on the east side of the river is suspended from the framework of the elevated railroad, and would cost considerably less than where trenching is necessary. In a city where the streets are paved the cost of trenching and repaving is offset when poles and wires are used by a more sightly and expensive set of poles, and the cost of trenching outside of the city limits or alongside of the steam railway tracks, where as many as from thirty to fifty wires are used, makes it in such localities cheaper to put the wires underground.

It was not the intention of the Pennsylvania Railroad Company to use these wires for telephone purposes. Fifteen telegraph conductors have been connected into the cable, and upon some of those conductors are operated with one hundred and thirty cells of battery at Broad Street Station in connection with dynamo currents at Jersey City. After all the telegraph conductors had been connected and working, some of the telephone circuits were connected in the cable experimentally, and those who use the telephones say they observed a marked improvement; and with these results all the telephone circuits are now brought through this cable, and each party using telephones makes the same favourable report. It should be borne in mind that they were previously in a special cable used for telephone purposes only, and although the rattle caused by the telegraph is observed, speech itself comes much more distinctly articulated.

AN INCANDESCENT LAMP "FREAK."

THE accompanying incandescent electric lamp, with a fracture of the globe and filament, presents somewhat curious and interesting features, writes G. W. Blodgett in the *Electrical World*. Several Bernstein lamps are run from the circuit of a Brush 16-light machine (lamps of 2,000 C.P.) belonging to the Boston and Albany Railroad Company. These Bernstein lamps are of 32 C.P. nominal, and are operated in series multiple—two in series and two in parallel. An automatic cut-off in a small iron box introduces a resistance in case any lamp fails, and thus protects its mate from like interruption or destruction.

The lamp was found in its present condition by the man who has charge of the circuits, and I do not know that any one observed it at the actual moment when the fracture took place. The globe, as will be seen, has on one side a funnel-shaped depression more than an inch in diameter at the mouth, with a hole in the bottom about a quarter of an inch in diameter. It will be seen, moreover, that nearly half of the filament is destroyed immediately opposite the depression or opening. The blackening of the interior of the globe would lead one to infer that the filament had been largely converted into dust and deposited on the glass.

A study of the peculiar appearance of this lamp indicates to me that it was broken in the following manner: The glass was thinner on the affected side of the globe than on the other, and became slightly softened by the heat from the filament. It then yielded to the pressure of the air from the outside, so that a slight hollow began to form on that side. The glass now became still thinner and hotter at this weak point, and yielded more and more until broken by the exterior pressure. Then and not before the filament was instantly destroyed. I shall be glad if any readers can throw further light on this theory and confirm it, or present one more probably correct.

Commenting upon the matter, the *Electrical World* says:—"Mr. Blodgett has given his neat theory regarding the manner in which the break may have occurred, but we have no doubt that others will seek another cause, in which the breaking of the filament itself may have been the prime factor in the destruction of the lamp. Thus we may assume that the breaking of the filament produced an arc which, after becoming longer and longer, finally heated up the glass of the surrounding globe sufficiently to cause the outer pressure of the air to indent and perforate as shown in the engraving."

TRAIN LIGHTING BY ELECTRICITY ON THE GREAT NORTHERN RAILWAY.

THE demand for improvement in the lighting of railway carriages is one that is not only made persistently by the traveller, but is also fully recognised by the companies and their managers who, so far from being worthy of blame for inattention to the matter, deserve credit for the number of attempts they have made both to improve the oil lamp and to substitute for it apparatus for burning mineral oil and specially prepared gas. Nor have the claims of electricity been ignored; experiments have been carried on for years past on the lines of some of the most enterprising of the companies with the view of adopting the system which should be found in practice the best adapted for the service. The necessary apparatus has now been brought to such a degree of perfection, and the lighting by this

means is proved to be so free from objection, that its general adoption by the railway authorities of the kingdom without further delay appears highly probable. The defects of the oil lamp are too familiar to need mention; at the best it gives poor light of a bad colour, which in the course of a journey of moderate length varies and diminishes, if it does not actually expire. Gas, though a great improvement on the oil lamp as regards the amount, the steadiness and the colour of the light, is said to be costly, while the addition to a train of a store of highly compressed gas involves additional risk in the event of accident, as was shown on a recent occasion on the Continent. Looked at from the railway company's point of view, the prime cost of the machinery and appliances necessary for the lighting of a train by electricity is a consideration. Against this, however, it must be borne in mind that so much do the travelling public appreciate a good light, that they will be ready to give a preference where possible to the lines of those companies who are prepared to provide for their comforts in this respect, so that there is a good prospect of the outlay being remunerative.

The Great Northern Railway Company has now four trains running from Kings Cross in which, under the direction of Mr. Jas. Radcliffe, the telegraph superintendent of the line, a most complete and efficient electrical plant has been fitted, and a fifth installation is in preparation for an express train to Edinburgh. A dynamo and set of accumulators are located in the van under charge of the guard, and a good idea may be formed of the simplicity of the arrangements from the following notice posted in the van.

"*Instructions to Guards.*"

"During daylight the switch is to be turned 'on' immediately the front brake enters a tunnel and 'off' directly the rear brake emerges from it. The light must be turned 'on' after sunset, five minutes before the train is due to leave the terminal station and on the approach of darkness when running, but must be turned off as soon as the passengers have left the carriages at the end of the journey."

Apart from the guard, all the attention necessary is that, before the starting of the train, an inspector sees that all is in order, and that the lubrication is properly provided for.

The machine found to be most suitable for the work is a Brush, shunt wound, giving from 45 to 90 ampères of current, according to the speed at which the train travels. This is driven from the axle of the train wheels, multiplication of speed being obtained by means of countershafting introduced between the train axle and the pulley on the driving gear of the dynamo. The direction of rotation of the dynamo is regulated by friction cones, two on the shafting and another fixed on an extension of the dynamo spindle.

The two cones on the shafting are carried by a hollow shaft or sleeve, mounted and free to move on the driving shaft and furnished with spiral slots engaging with projections on the latter. By this means the opposite diameters of the cone on the dynamo spindle are automatically brought against either one or other of the cones on the shafting, according to the direction of the motion of the train, with the result that whichever way the train may be running the dynamo is always driven in one uniform direction, so that no reversal is needed, or any shifting of brushes or readjustment of any kind.

This arrangement has been designed and patented by Mr. Radcliffe. The accumulators are of the E.P.S. manufacture, 11 L type, and are automatically connected with and disconnected from the dynamo by means of a switch or controller, also designed and patented by Mr. Radcliffe and manufactured by Messrs. Reid Brothers. When the train is at rest the lamps are fed from the accumulators, but when running, and when the E.M.F. of the dynamo rises above that of the accumulators the dynamo is automatically connected to the accumulators and lamps, between which the current generated is divided, the accumulators taking the surplus over what is required for the lamps; when the speed slackens and the E.M.F. falls below that of the accumulators, the switch or controller automatically cuts the dynamo off, and the lamps are again fed from the accumulators.

A fusible cut-out is employed in such a way that in case of an accidental short circuit or mishap of any kind everything would be disconnected except the lamps with the accumulators, so that the lamps would run on. The cessation of light in any compartment is also guarded against by the system of wiring, a middle wire being run along the roof of each carriage, affording, in case of the accidental giving out of a lamp, a circuit by which the current finds its way to the rest of the lamps, and there being two lamps in each compartment there is hardly a possibility of its being left in darkness.

We recently had an opportunity of inspecting a train fitted up on this system running between London and Barnet. There were 92 lamps of 6 C.P. throughout the train, each compartment having within the usual roof globe two of these lamps, affording quite sufficient light to enable the occupants to read their newspapers with comfort; in fact, the illumination was nothing less than perfect. The guard switched lights on and off as required on entering and leaving the tunnels, and evidently did not find this extra duty at all an onerous or difficult one. The dynamo in this train was cased with boards, and a lid enclosed it in a kind of box. The accumulators, of which there were 44, were shut up in cupboards fitted with shelving, and everything was compact and ship-shape. The whole installation is of the most substantial character, and fully capable of bearing the extra jolting and rough usage inseparable from railway work. The total weight of the equipment is estimated at from 2 to 3 tons, and its cost not much less than £400. To meet the difficulty of getting railway companies to expend the amount of capital involved in fitting up their trains with these electrical appliances a proposal has been made to form a limited liability company with a capital sufficient to enable it to fit up the apparatus and charge the railway company a rental. It is calculated that a handsome return could be made by the shareholders, while at the same time the railway companies would improve the lighting of their carriages and effect an economy, as compared with their present outlay for gas or oil.

LEGAL.

Gaulard and Others v. Sir Coutts Lindsay and Co. and Ferranti.—Court of Appeal, Wednesday.—Before Lords Justices Cotton, Lindley and Bowen.—This was an appeal from a decision of Mr. Justice Kekewich. The action was brought by Messrs. L. Gaulard and J. D. Gibbs and the National Company for the Distribution of Electricity by Secondary Generators, Limited, against Sir Coutts Lindsay and Co., Limited, and Sebastian Ziani de Ferranti to restrain the infringement of five letters patent of the plaintiffs. On the 21st of November, Mr. Justice Kekewich, in the matter of a petition presented by Ferranti for revocation of one of the patents, made an order giving the plaintiffs liberty to apply at the Patent Office to amend the specification of that one of the letters patent. The plaintiffs afterwards moved for liberty to apply at the Patent Office to amend the same specification by way of disclaimer, correction, or explanation, and that in the meantime the trial of this action might be postponed, and that the specification, when amended, might be used in evidence at the trial on such terms as the Court might think fit. The application was made under section 19 of the Patents, Designs, and Trade Marks Act, 1883, which provides that "in an action for infringement of a patent, and in a proceeding for revocation of a patent, the court or judge may at any time order that the patentee shall, subject to such terms as to costs and otherwise as the court or judge may impose, be at liberty to apply at the Patent Office for leave to amend his specification by way of disclaimer, and may direct that in the meantime the trial or hearing of the action shall be postponed." Mr. Justice Kekewich was of opinion that it would be unreasonable to allow a postponement of the action as to all the patents. And he said that if the plaintiffs would not accept the defendants' offer, that the plaintiffs should discontinue the action as to the one patent and pay the costs as to that, the motion must be refused with costs. These terms being refused by the applicants' counsel, the motion was

accordingly refused with costs. The plaintiffs appealed. Before the conclusion of the arguments the plaintiffs consented to the order which they asked being made upon the following terms (which the defendants were willing to accept):—That the plaintiffs should pay all the costs of the action up to the present time, and that they should not claim any relief in respect of anything done by the defendants before the amendment of the specification, the defendants to have liberty to amend their defence and particulars of objection. LORD JUSTICE COTTON said the appellants had now offered terms which would do complete justice in the present case. This offer had not been made in the Court below. As the plaintiffs were asking for an indulgence, they must pay the costs of this application in both Courts. LORD JUSTICE LINDLEY and LORD JUSTICE BOWEN agreed

NOTES.

Electric Lighting at Exeter.—Permission having been obtained from the Council for the erection of poles in the city, some experimental electric lighting is being carried out at Exeter. The firm executing the work has announced through its local agents that it intends lighting the streets for a month.

Electric Lighting of a Yacht.—The *Lyra*, steam yacht, belonging to Sir William Brown, Bart., has been supplied throughout with the electric light. Motive power is produced by a small engine, and not only have the saloons, cabins, and every nook of the little craft been illuminated, but the riding lights at the masthead and the coloured side lights are also fed in connection with the electrical system. A successful trial of the electric apparatus was made a few days since while the *Lyra* was at her moorings in Portsmouth Harbour.

Electric Lighting in Clubland.—The electric light is being installed, established, and developed at most London clubs, says the *County Gentleman*. For a while the committees at the Old World establishments hesitated to follow the lead given by such dashing youngsters as the men of the Naval and Military and the Junior Carlton. The Carlton proper was electrified in October last, and who knows but that the Senior and the Athenæum may not have a shock one day soon? The steady-going St. Stephen's Club is no longer to be lit by gas and lamps, as specifications are now out for electric lighting tenders. The new light in most cases is admitted not for light, but because it is cooler than gas and sweeter than oil. The atmosphere at most clubs during the fogs of a fortnight ago was really intolerable.

Folkestone and the Electric Light.—Messrs. Laing, Wharton and Down, as the representatives of the Thomson-Houston Company, have offered to run a small plant of 15 arc lamps of 1,200 C.P. each for a fortnight for the illumination of the Lees at Folkestone for £75, finding their own power and keeping the lamps alight from dusk till 11.30, or, if the Corporation will undertake to purchase at the end of the trial, they will run the same plant for 12 months for £400. The price they would ask for the plant would be £1,100, exclusive of the cost of lamp posts, which would amount to about £6 each; the cost of working if the Corporation purchased the plant would be approximately £250 a year. At a meeting of the Council on Wednesday it was decided, conditionally, to adopt the electric light, and a committe was appointed to consider the matter.

Electric Lighting at the Leeds Town Hall.—At a meeting of the electric lighting committee of the Leeds Town Council on Thursday last week, it was decided at once to place 100 incandescent electric lamps in the Mayor's Rooms, Town Hall. The arrangements for a large installation required to light the Fine Art Gallery, the Victoria Hall, and all other parts of the Town Hall, and the Municipal Buildings, will be considered by the committee shortly.

Southport and the Electric Light.—The electric light is to be established in Southport. The Maxim-Weston Company, of which Mr. H. Hodge is the local agent, intends to set up in the town a dynamo, and anyone who wants an electric lamp put up on his premises can have it at the charge of one penny per hour's use of the light.

Bradford and the Electric Light.—A meeting of the members of the gas supply committee of the Bradford Corporation was held last Friday at the Town Hall to confer with Dr. John S. Hopkinson, F.R.S., in reference to the electric lighting of portions of the borough by the Corporation. Mr. J. N. Shoolbred, an electrical engineer retained some time ago, having prepared a scheme upon a basis suggested by the gas supply committee, it was thought desirable that an eminent authority in such matters should be called in, with the view of some feasible scheme being adopted. Hence the interview, which lasted nearly the whole of the day, Mr. Shoolbred being present. Dr. Hopkinson, accompanied by the members of the committee, examined various sites for the necessary plant required in carrying out the suggested scheme, and concurred in the view of the committee that the land belonging to the Corporation in Bolton Road lying near to Balme Street was the most suitable. As to the area to be supplied with the electric light, it was thought desirable that an installation be laid down on the site suggested of sufficient power to supply the central portion of the town, lying in the vicinity of Kirkgate and Market Street, as already approved by the council, to be on the low-pressure continuous current principle. As a result of the interview, it was ordered that a specification of the proposed works be prepared by Mr. Shoolbred, to be submitted to Dr. Hopkinson, which being approved, the works will be let by tender, the specification being so framed as to give an opportunity to the council for securing the best electrical appliances possible, compatible with the cost being brought within the sum of £15,000 proposed to be expended by the Corporation as a first outlay, the works to be so arranged that, if deemed necessary, they may be extended in accordance with the wishes of the council.

Gravesend and Electric Lighting.—At the monthly meeting of the Gravesend Tradesmen's Association the subject of electric lighting was introduced. Mr. Pope, an electrician, explained the great advantage to be derived from electric lighting, and concluded by moving that in the opinion of the association the electric light possessed advantages which commended its use to the inhabitants of the town generally. Mr. Hatch seconded the motion, and it was carried.

Chicago and the Electric Light.—Prof. Barrett, the city electrician of Chicago, has, at the request of the council, prepared an estimate of the cost of electric lighting for the city, public and private. Basing his estimate upon an installation of 75,000 lamps of 16 C.P., with an equipment of 175,000 lamps, and a daily average of 840,000 lamp hours, he found that the first cost would be $1,950,000, and the daily maintenance $1,870 for a central station (incandescent) system. For a municipal system, the cost of plant would be $541,698, and of daily maintenance $127. For an arc lighting plant (750 double lamps), the cost of plant would be $435,230, and of yearly maintenance $35,900. He gave the following comparison of the cost of gas and electric lighting:—

	No. of lights.	C.P.	Cost per annum.
Gas	3,273	52,368	$61,756 26
Incandescent	3,273	98,190	46,730 00
Arc	750	1,500,000	35,900 00

Electric Lighting in Ipswich.—The electric light is to be introduced into Mr. George Mason's extensive oil mill, St. Peter's, Ipswich, and Messrs. Footman, Pretty, and Nicolson have decided upon extending its use at Waterloo House.

Leamington Electric Lighting.—From a Birmingham paper we learn that the leads put down ready to be connected with the remaining standards in the Parade at Leamington, and which will be substituted for the existing lamp posts, are being uncovered, insulated, and protected by leaden piping. It is believed that this will prevent the short-circuiting which has recently occasioned so much difficulty, and we are informed that this forms no part of the Callender system.

Telephonic Extension at Plymouth.—Arrangements have recently been made at Plymouth, with the view of connecting the cab rank in Westwell Street with the telephone exchange, for the convenience of subscribers wishing hurriedly to summon cabs. The call office at Plympton is now open, and on payment of sixpence three minutes' conversation can be had with any subscriber in the three towns.

The Portsmouth Telephone Exchange.—At the annual meeting of the Portsmouth Chamber of Commerce on Thursday, reference was made to the gratifying progress achieved by this exchange, which has now a membership roll of 140, and is increasing daily. It was stated that the number of calls on the 19th ult., the day of the banquet to Mr. Walter Besant, was 865, which the President (Mr. W. Edmonds) said would compare favourably with the best London averages. During the week of the Jubilee naval review, the calls recorded reached an average of 1,000 a day, The Western Counties and South Wales Telephone Company is now contemplating telephonic communication between Portsmouth and Southampton, and the opening of exchanges at Gosport and Fareham. All four towns would then be linked together.

The Telephone at the Dundee Exhibition.—The National Telephone Company has an extensive display in the exhibition now open at Dundee, which has been dubbed "The Traderies." It includes specimens of the instrument and apparatus in practical use, from the subscribers' instruments to the switch-table, attended by a trained operator. The stand is in connection with the Company's Dundee Exchanges, and from it conversation can be held with subscribers in Dundee, Broughty Ferry, Newport, Tayport, Monifieth, Perth, Forfar, Arbroath, Kirkcaldy, Dunfermline, Stirling, Bridge of Allan, Alloa, Falkirk, and Grangemouth, &c.

The Telephone from Paris to Marseilles.—Some interesting experiments on long distance telephony were made last week in connection with the proposed telephone line from Paris to Marseilles. In order to obtain a line 1,000 kilometres long the line from Antwerp to Brussels was connected with that from Brussels to Paris; these were connected with the line from Paris to Brussels *viâ* Momignies, which had been previously connected with that from Brussels to Verviers. Thus the total length from Antwerp to Verviers was about 1,000 kilometres. Speech was clearly understood on this line, which is composed of bronze wire of tolerably high conductivity. The work of erecting the line from Paris to Marseilles has already commenced at some points. The wires, of silicium bronze, will be subterranean as far as Nogent-sur-Marne, after which they will be carried on the posts along the railway. The line is expected to be in operation about July next.

Proposed Telephone Exchange for Cheltenham.—A meeting was held at the Municipal Offices on the 24th ult., for the purpose of ascertaining whether sufficient support would be extended to the Western Counties and South Wales Telephone Company to enable it to open an Exchange in Cheltenham, and to connect it with the system at Gloucester and other towns in the West of England and South Wales. Mr. H. F. Lewis, general manager and secretary to the Company, attended to give information on the subject. The Chairman mentioned that the General Purposes and Watch Committee of the Corporation had under consideration the question of providing quick communication between the extreme parts of the town and the Fire Brigade station, and he thought he might say the Corporation would be favourably disposed towards the Telephone Company if it provided the means for that communication. Mr. Lewis then gave an account of the progress of the company he represented. If the company could obtain twenty subscribers, it would at once open a local Exchange in Cheltenham, upon an overground wire system, at the following rates for each connection within a radius of a mile of the Exchange—which it was suggested should be in or near North Street:—For one year, £12, or 4s. 7d. per week; for four years, £11 per annum, or 4s. 2d. per week; for seven years, £10 a year, or 3s. 10d. a week. The Company offered three months' free rental to the first twenty subscribers in the town. It was their intention to connect Cheltenham with Gloucester, and as that city was connected with Bristol and Bath, and with the principal towns in South Wales, subscribers could be placed in immediate communication with those towns. The trunk rate between Gloucester and Cheltenham would be £5 per annum at each end. The Company would, after the establishment of the Exchange in Cheltenham, open as many call offices as were required, where, for the small charge of twopence, anyone could communicate with any subscriber upon the Exchange system. The system, Mr. Lewis added, would be connected free of charge with the police station, the fire-brigade station, and the hospital; and, in answer to the Chairman, Mr. Lewis said he would also recommend that the Delancey Fever Hospital should be connected without charge. On the proposition of the Chairman, seconded by Mr. Norman, a vote of thanks was accorded to Mr. Lewis, and this having been acknowledged, the meeting terminated.

A Telephonic Concert.—The residents of Stafford have just had a novel experience with the telephone. It is not long since the exchange was opened, but interest in the telephone is growing, and will undoubtedly receive an impetus as a consequence of the concert which took place last week and was transmitted from the residence of Dr. Taylor in Wolverhampton Road to that of Mr. Rooper in Greengate Street. Sixty persons were assembled at the latter place, and listened attentively to the music that came over the wires, expressing their delight and admiration unanimously afterwards. Mr. Alfred L. E. Drummond, the courteous district manager of the National Telephone Company, gave the needful explanations, and was accorded the thanks of the assemblage at the close of the proceedings.

The Telephone in Norfolk.—There is a probability of a telephone wire being laid to Gorleston, in connection with that at Yarmouth and other parts of the county.

International Exhibition, Paris, 1889.—In view of the interests of English electrical exhibitors, the Society of Telegraph-Engineers and Electricians has appointed a committee to endeavour to ascertain their wishes, and to make arrangements on their account with the French authorities. The Director-General of the International Exhibition having requested the society to take part in the matter on behalf of the official administration, it is proposed shortly to address a circular to the principal firms interested in electric lighting and kindred pursuits, and to convene a meeting of gentlemen who are likely to take part as exhibitors in the forthcoming display. It is of extreme importance to British industries that they should be well represented, as there is danger of Continental opinion assuming that England has fallen back in the race.

Underground Conductors.—For the account of the new system of underground conductors devised by Mr. Brooks, which we describe this week, we are indebted to that gentleman himself. We shall probably have some comments to make upon both the method and the tests in our next issue.

The Society of Telegraph-Engineers and Electricians.—The next meeting will be held at the Institution of Civil Engineers, 25, Great George Street, Westminster, S.W., on Thursday, February 9th, 1888, when a paper "On Alternate Current Transformers with Special Reference to the best Proportion between Iron and Copper," will be read by Gisbert Kapp, A.M. Inst. C.E., member.

Manville and Madgen's Electrical Supplies.—The United Electrical Egineering Company has forwarded us its new list, giving particulars of the Jablochkoff system of arc lighting, of the small arc lamps of 300 C.P. and upwards, which are being introduced by the company under the somewhat awkward name of "arc-ettes," and of numerous other specialities. The index to the list looks like an old friend transferred bodily from a list of supplies already familiar to us, and as if inserted here to show both what is in the book and also what might have been but is not. In this respect it is rather a novelty in the art of indexing.

Liverpool Exhibition Buildings.—In our "Notes" last week we erroneously stated that Messrs. Wheatley Kirk, Price, and Goulty were about to sell by auction the engines and plant of the Royal Jubilee Exhibition at Liverpool. In this we were mistaken—what the firm is about to sell is the whole of the *buildings* comprising the aforesaid exhibition — but there are no engines, boilers, or plant to sell, these having been removed some time ago by the contractors for the electric lighting. Preliminary notice of the sale will be found amongst the advertisements in the present number.

The Stratford Electric Tramcar Experiments.—Addressing the shareholders of the North Metropolitan Tramway Company on Wednesday, Mr. George Richardson, the chairman, said it was as well to tell them that certain experiments were going on in reference to electricity. Whether they would turn out to be satisfactory or not he could not say, but if they failed the company would lose nothing, as the cost was defrayed by the people interested in the electricity. If it could be shown that the experiment worked to advantage, then the company would of course reap the benefit of it.

The Institution of Mechanical Engineers. — Mr. William Geipel, of Edinburgh, was announced to read a paper on "the position and prospects of electricity as applied to engineering," before the Institution of Mechanical Engineers yesterday.

Royal Society.—At the meeting yesterday afternoon a paper was announced to be read by Dr. Wright, F.R.S., and C. Thompson, "On the voltaic circles producible by the mutual neutralisation of acid and alkaline fluids, and on various related forms of electro-motors."

Electrical Measuring Instruments.—The letter of Prof. Elihu Thomson explains the reason of the appearance of his article in our columns this week. We trust that the drawings, which were sent to us on copying paper, reproduced from rough pen and ink sketches, will be found sufficiently clear to illustrate the text to the satisfaction of Mr. Swinburne.

New Firm.—We understand that three gentlemen, Messrs. Appleton, Burbey and Williamson are about to commence business as electrical engineers and contractors, at Balmoral Buildings, Queen Victoria Street, E.C. There is room for them, and we wish them success.

The Cable War.—There is a rumour that the contest between the Atlantic cables is to end at last. The subject will probably be mentioned at to-day's meeting of the Anglo-American Telegraph Company.

Theatre Fires.—The Variedades Theatre at Madrid was destroyed by a fire which broke out at six o'clock last Saturday morning. The fire is supposed to have originated among the scenery and machinery beneath the stage. The Variety Theatre, really a music-hall, at Steubenville, Ohio, was recently burned down one afternoon, and, the fire spreading to an adjoining hotel, Miss Annie Devoe, one of the performers, was burnt to death.

To Investors. — The following advertisement is clipped from a daily paper this week :—"Capital required, for placing before the public, in February, an unrivalled primary battery, fully tested and patented quite recently, capable of yielding six hours' electric light daily for a month without attention, at little more than the price of gas; two subscribers of £500 each can be elected to the Board, but smaller sums may be invested in shares; liability limited."

Induction in Conductors.—In consequence of the constantly increasing difficulties arising from mutual induction among electrical conductors, the Electrotechnical Society of Berlin has recently nominated a commission to draw up a code of regulations. This commission includes the most eminent representatives of electrical science in Germany: Messrs. Werner Siemens, Bensen, Elsasser, Massmann, Hucke, Triebel, von Helmholtz, Paalzow, von Miller, Brix, Frœlich, Wilhelm Siemens, Rühlmann, and Golz. It is expected that the results of these researches will be of great value to electrical industries.

The Prince and the Cables. — Prince Bismarck appears to have become involved in a quarrel with the Commercial Cable Company. If the facts are as stated to us, the veteran statesman is as arbitrary as ever, but has chosen a less pliant subject than usual. Notifications were issued that no telegraph office was to receive telegrams for America bearing the indication that they were to be transmitted by the Commercial Cable. Merchants, bankers and brokers in Berlin and other important towns were indignant, and the Company went straight to the American Minister. The cause of the prohibition is said to be that the Company has transgressed by sending out agents to solicit business. The agreement entered into at Berlin in 1885 is clear enough in providing that the sender of a telegram shall have the right of prescribing by what route it shall be transmitted, and the Cable Company urges that it is no concern of the German authorities whether it solicits business or not.

Automatic Delivery Boxes. — In our notice of registered companies, we give some particulars of the Electrical Automatic Delivery Box Company. We have since seen the prospectus, from which we learn that the purchase consideration is £30,000, £10,000 in cash, and £20,000 in fully paid shares. The joint patentees and inventors are to be the consulting electricians to the Company, the minimum dividends of which are estimated at 30 per cent. per annum. Taking into consideration the huge capital, the exorbitant purchase consideration, and the estimated dividend, the scheme does not commend itself except for its novelty, which is only transient after all.

Electric Lighting in Germany.—We learn from a contemporary that about 15,000 arc lights and 170,000 incandescence lamps, supplied from about 4,000 dynamos, are in actual use in Germany.

Cable Tramway Accident.—At St. Paul, Minnesota, a car lost its grip of the cable whilst descending a hill, and was thrown off the rails. Fourteen of the occupants sustained injuries, which it is feared will, in several cases, prove fatal. Another argument in favour of electric traction.

NEW COMPANIES REGISTERED.

Electrical Automatic Delivery Box Company, Limited.—Capital, £60,000 in £1 shares. Objects: To acquire the benefit of the letters patent granted to Frank Villiers-Stead for electrical automatic delivery boxes (No. 13,005). Signatories (with one share each): F. Villiers-Stead and E. R. Hedgman, electrical engineers, 50, Lombard Street; L. W. Balck, 8, Cecelia Road, Tufnell Park, N.; J. T. Galloway, 50, Old Broad Street; G. W. McChan, 7, Moorgate Street; R. Sindall, Catford; Alfred Dale, 22, Pooles Park, N. The signatories are to elect the first directors, qualification 100 shares. Remuneration, £150 per annum to the chairman, and £100 per annum to each other director, to be doubled when the dividend exceeds 10 per cent. per annum. Registered 26th ult. by J. M. Mitchell, 110, Cannon Street.

Series Electrical Traction Syndicate, Limited.—Capital, £30,000 in £1 shares. Objects: To acquire a license to use certain patented processes for the purpose of traction, propulsion or locomotion on tramways, and to carry out an intended agreement between Henry Foote and Carl von Buch. Signatories (with one share each):—Carl von Buch, M.A., 1, St. James's Street, W.; E. Bergholt, 45, Lansdowne Gardens, Clapham; J. P. Hurst, 12, Furnival's Inn; Henry Foote, 11, Gloucester Walk, W.; F. Prestidge, 24, Coleman Street; F. Upson, 3, Lavell Street, Stoke Newington; W. Brown, 11, Cleveland Terrace, Stamford Hill. The signatories are to nominate the first directors, qualification £50 in shares or stock; the company in general meeting will determine remuneration. Registered 31st ult. by Harries Wilkinson and Raikes, 24, Coleman Street.

DEFUNCT ELECTRICAL COMPANIES.

THE following companies, not having complied with the requirements of the Companies Acts, have been struck off the register:—

House and General Electric Lighting Company, Limited.—This company was registered September 26th, 1884, with a capital of £75,000 in £1 shares, to acquire patents relating to electricity, and for such purposes to enter into agreement dated August 7th, 1884, between Arthur Beckwith, of 10, Noble Street, and T. W. Martin, of 32, St. Swithin's Lane. A letter addressed to the Registrar on June 25th, 1887, states that the company did not go to allotment and never did any business, and that on August 25th, 1885, a resolution was passed annulling the contract with the vendor. The company had no liabilities whatever, and was dissolved by notice in the *London Gazette* dated 13th ult.

Electric Light Enlarged Photograph Company, Limited.—This company was registered June 30th, 1880, with a capital of £10,000 in £1 shares to purchase and work the patent rights of Ferdinand H. Warlich for improvements in producing enlarged pictures by the agency of artificial light. At a meeting held on January 14th, 1881, at the offices of W. Berry, Greening and Co., 40, King Street, Cheapside, it was proved that by reasons of its liabilities the company could not continue its business and it was resolved to wind up. No return has since been made, and the company has accordingly been dissolved.

Gower-Bell Telephone Company, Limited.—This company was registered August 28th, 1880, with a capital of £200,000 in £10 shares to manufacture and lay down telephones. The last return was filed on June 27th, 1882, and is made up to the 16th of that month. This return shows that 26 shares were taken up and that no call had been made or paid thereon. The company is now amalgamated with the Consolidated Telephone Construction and Maintenance Company, Limited.

Steamship and General Electric Telegraph Company, Limited.—This company was registered 1st May, 1880, to acquire and work the patent rights of John Sacheverell Gisborne for improvements in ship telegraphs (No. 3,428, dated 30th August, 1878). The last return, made up to the 30th June, 1883, was filed on the 24th of that month. The document states the nominal capital to be £4,000 in £5 shares. 670 shares were taken up and the full amount had been called thereon, the total calls paid being £3,345, and unpaid £5. The company has not done business for about three years.

International Submarine Telegraph Company, Limited.—This company was registered 4th August, 1880, to purchase from G. F. Smith a concession from the Portuguese Government for landing cables on the islands of the Azores. The nominal capital of the company was £1,250,000 in £20 shares, but beyond the seven shares subscribed for by the original signatories no shares were taken up. A letter states that the company probably collapsed upon the death of Mr. Smith in July, 1881.

CITY NOTES, REPORTS, MEETINGS, &c.

Anglo-American Telegraph Company, Limited.

THE report of the directors to be presented to the ordinary general half-yearly meeting of the proprietors to-day states that the total receipts from the 1st July to the 31st December, 1887, including the estimated balance of £18,323 6s. 8d. brought forward from the last account, are estimated at £113,283 6s. 5d. This amount, however, is subject to revision upon settlement of the accounts for the year with the Paris-New York Telegraph Company. The traffic receipts show an increase of £9,460, as compared with the corresponding period of last year.

The total expenses of the half year, including repair of cables, &c., as shown by the revenue account, amount to £49,688 8s. 1d.

Interim dividends of 7s. 6d. per cent. on the ordinary stock, and 15s. per cent. on the preferred stock, were paid on the 1st November last, absorbing £26,250, leaving an estimated balance of £37,344 18s. 4d., out of which the directors recommend the proprietors to declare final dividends of 10s. per cent. on the ordinary stock, and 20s. per cent. on the preferred stock, amounting to £35,000, making a total distribution for the year ended the 31st December, 1887, of £1 7s. 6d. per cent. on the ordinary stock, and £2 15s. per cent. on the preferred stock, leaving an estimated balance of £2,344 18s. 4d. to be carried forward to the next account.

The company's repairing ss. *Minia* has been engaged during the past half year in the repairs of the Duxbury, Brest and North Placentia cables, which were effected on the 28th August, and the 12th and 20th September respectively.

The Brest-St. Pierre cable, broken on the 9th November, 1886, at a distance of 600 miles from St. Pierre, in 2,750 fathoms, was picked up on the 6th August, 1887, in 2,300 fathoms, communication being restored on the 12th September as above stated—220 miles of new cable were used in this repair. Considerable damage was sustained by the ship in a cyclone during these operations, involving the necessity of her going to New York to refit.

The Duxbury cable was again broken on the 2nd of September off Canso, Nova Scotia, on this occasion by the ss. *Pouyer-Quertier* which was at the time engaged upon the repair of one of the Commercial Company's cables. That company at once gave orders to the master of the *Pouyer-Quertier* to repair the cable which he had inadvertently broken, and the work was effected on the 12th of the same month.

During the repairing operations off Valentia, Ireland, in December, 1886, it was found that from the rocky nature of the coast at the landing place of the cables the shore ends had become so greatly damaged by the action of the sea that their renewal and removal to a more suitable locality was absolutely necessary. New shore ends were accordingly laid into Cooscroom, Dingle Bay, which has the advantage of a sandy bottom. The alterations were carried out in the month of September last without interruption to the communication.

The 1873 cable was broken in Trinity Bay, Newfoundland, on the 9th of December, but was repaired within 24 hours by the officials of the station at Hearts Content.

The company's system of cables and land lines is in good working order, with the exception of the Brest-St. Pierre Cable, which the directors regret to report was again broken on the 4th of October last, at about 1,034 miles from Brest, in a depth of 1,500 fathoms, and at a distance of 1,000 miles east of the previous break. The ss. *Minia* will proceed to the repair of this interruption in the spring.

The action brought by the company against the Paris-New York Telegraph Company, to compel that company to resume performance of the joint-purse agreements of 1880 and 1882, which they had ceased to carry out since the 31st December, 1886, was argued before the Paris Tribunal of Commerce on the 12th December last.

The judgment of the Tribunal was pronounced on the 9th ult., in favour of this company, with damages of 2,000 francs per day from 31st December, 1886, to the date of service of the judgment. The Tribunal also condemned the defendants to pay 5,000 francs per day from the service of the judgment, for one month, when the Court will decide as to future damages, unless in the mean-

time the defendants have resumed fulfilment of the agreements, or obtained from the Courts, which according to their concession should determine the question, a decision that such agreements are illegal. The Paris-New York Telegraph Company are also to pay the costs of the action. They have announced their intention to appeal.

In the autumn of last year lengthened negotiations took place in New York between the Western Union Telegraph Company and the Commercial Cable Company (Mackay-Bennett Cables), with a view to the purchase or lease of the latter company's cables. The terms demanded by the Commercial Cable Company, however, were of such a character as to preclude their acceptance.

During the progress of the negotiations, the representatives of the Commercial Company threatened that unless their terms were agreed to they would immediately adopt the 6d. rate. It is almost needless to say that the joint-purse companies were prepared for this declaration, as they fully anticipated it when they commenced that rate. The Commercial Company reduced their tariff from 1s. to 6d. per word on the 15th of September.

The traffic passing over the lines of the joint-purse companies during the past half-year shows an increase of 12 per cent. over that of the corresponding period in 1886, the tariff being the same, viz., 6d. per word, and an increase of 162 per cent. over the same period in 1885, when the tariff was 1s. 8d. per word. The adoption of the low rate by all the companies has resulted in a very considerable augmentation of the total Atlantic traffic, but it is as yet unremunerative.

The project of the International Cable Company, which was launched in 1886, for the purpose of laying cables between Europe and North America, &c, *via* the Azores, still remains in abeyance. At a recent meeting of the shareholders of that company, it was decided to postpone further action for six months, in anticipation that the low rates of the existing Atlantic Cable companies would shortly come to an end.

The Cuba Submarine Telegraph Company, Limited.

THE report of the directors for the half-year ending December 31st, 1887, says that from the balance sheet and accounts it will be seen that the gross receipts (including the balance brought from last account) amount to £19,741 3s. 10d., and the gross expenditure (including the half of the annual payment on account of the 1881 cable) to £6,368 14s. 9d., leaving a sum of £13,372 9s. 1d. to the credit of revenue account.

Of this the sum of £3,000 has been added to the reserve fund, increasing that fund to £74,000.

The dividend on the preference shares will absorb £3,000 and leave £7,372 9s. 1d., out of which the directors recommend the payment of a dividend on the ordinary shares at the rate of 8 per cent. per annum, free of income tax, the balance, £972 9s. 1d., being carried forward to the current half-year's account.

The main cables have continued in good working order throughout the half-year, although the Cienfuegos-Batabano section is showing signs that some repairs may shortly have to be made upon it.

A new harbour length has been laid by Mr. Keith at Cienfuegos to replace the duplicate working length which has become worn out.

An additional store for the reception of spare cable has been built upon the company's ground at Cienfuegos, and the cost charged to capital expenditure account.

The Submarine Telegraph Company, Limited.—The accounts for the half-year ending December 31st, 1887, show a balance, subject to audit, which enables the directors, after adding 15 per cent. of the gross receipts to the reserve fund, to recommend a dividend at the rate of 15½ per cent. per annum.

The Consolidated Telephone Construction and Maintenance Company, Limited.—Mr. J. H. Buckingham, of No. 93, Wood Street, Cheapside, has joined the board of this company.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the weeks ending January 13th and January 20th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,875 and £1 722 respectively.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the weeks ended January 13th and January 20th, amounted to £3,879 and £3,023 respectively.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

AN ordinary general meeting of this society was held on Thursday, January 26th, Mr. E. GRAVES, President, in the Chair. The minutes of the last ordinary general meeting having been read and confirmed, and the list of new and proposed new members announced, the adjourned discussion on Mr. A. C. Cockburn's paper on "Safety fuses for electric light circuits, and on the behaviour of the various metals usually employed in their construction," was resumed.

Prof. SILVANUS THOMPSON thought that hardly sufficient prominence had been given to the effect which the terminals to which the safety fuses were attached had upon the latter; it had been stated that 1½ inch was the length for every fuse, but this length, he thought, would not do in the case of thick wires. It was necessary to have large terminals where large wire was used, and this made it imperative to have longer wires where the latter were of large diameter. The conductivity of the terminals for heat required to be taken into consideration, as copper, for instance, conducted heat better than brass. He was very much struck with the smallness of the percentage of variation from the nominal current at which the fuses were required and designed to act.

Mr. A. SIEMENS stated, with reference to the idea that fuses were not generally properly designed, that in Messrs. Siemens's price list the fuses required to protect particular sized wires were named, and they were constructed to act with nominal currents.

Mr. KILLINGWORTH HEDGES said that the idea of putting fuses in mechanical tension was by no means new, he had himself designed such a fuse several years ago, which he now exhibited; it consisted of a foil pulled apart by a spring when required to act. Sir William Thomson had also designed such fuses, in fact, had practically done all that Mr. Cockburn had done. The loss of energy in Sir William Thomson's fuses was but ¼ of a watt, he would inquire what it amounted to in the fuses of Mr. Cockburn, he thought it would be probably much higher. In his own fuses, where foil between mica was used, the energy absorbed was 1 watt per 6 ampères. The accuracy of foil fuses had been questioned, but this, he maintained, was simply a question of cutting them to the proper size. The protection of lamps themselves was an important point which ought to have careful consideration. Referring to the careless way in which fuses were looked after, he had found a case in which a thick piece of lead cable had been inserted in a fuse box, rendering the latter, of course, quite useless for its purpose, as the lead would require 800 ampères at least to melt it. The margin to be given to fuses ought to be definitely settled; the Phœnix rules state 50 per cent. for single and 25 per cent. for double pole leads; the rule drawn up by the Society was different altogether, and stated a temperature of 150° F., a statement which he quite failed to comprehend the meaning of.

Mr. PREECE said the subject of fuses was one to which he had paid a great deal of attention, chiefly, however, from a scientific point of view. He thought that Mr. Cockburn was the first person who had gone to work on the subject in a systematic manner. Edison was the originator of fusible cut-outs, but as he had not patented the idea, he had lost any commercial benefit which might have been derived from it. He (Mr. Preece) had had four years experience of Mr. Hedge's foil fuses, and he had found them to be very useful; Sir William Thomson's fuses were satisfactory also. The question of cut-outs had, he thought, been greatly overdone, for although the fuses had their value, they had also their defects. In one building where fuses had been largely introduced, it practically meant the introduction of 6,000 bad joints. He believed that nine out of ten failures in electric light systems had been caused by cut-outs. In 1884 he had read a paper before the Royal Society on the heating effects of electric currents. The origin of this paper was the fact that for twenty years past all submarine cables connected to land lines had been protected by cut-outs of fine platinum wire, and it became desirable to ascertain the exact size which the wire should have, in order that it might not fuse unless the current passing was in excess of what the cable could bear with safety. The law relating to the heating of wires of different diameters by different currents had been worked out first by Mr. Kempe, and given in the ELECTRICAL REVIEW,* and had subsequently been also given by Professor Forbes. This law showed that the current required to heat a wire to a definite temperature varied as the cube of the square root of the diameter of the wire. The law was not verified in the case of very fine wire, but was in the case of thick wires. For some time past he had been conducting experiments to determine the value of the constant a, for various metals in the formula

$$c = d^{\frac{3}{2}} \times a$$

and the results of these were given in a paper communicated to the Royal Society. The error produced by the cooling effect of terminals was referred to in this paper. The question of Mr. Killingworth Hedges relative to the rule laid down by the Society as to the heating of conductors, meant simply that the latter should never be allowed to rise above 150° F. In the experiments he had made there were three fiducial points which had to be determined: 1st, the current required to raise the wire to a temperature at which shellac melted; 2nd, whether all substances became visibly red at a temperature of 525° C., and 3rd, the currents required to fuse the wires. A large number of wires of different guages and different metals were experimented on. A curious fact was noted in the experiments, viz., that shellac acted as a flux and protected the surface of the wire from oxidation, the result being that 25 per cent. less of current was required to fuse tin wire than was the case when it was uncoated. It was

* ELECTRICAL REVIEW, June 24th, 1882, page 454.

also brought out that the current required to bring platinum to the temperature of the three fiducial points were as 1 : 2 : 3. A second series of experiments were also undertaken in order to determine the effect of sudden bursts of current on wires. It was found that tin wire, under these conditions, burst and flew about in all directions; platinum behaved best in this respect, but the conclusion come to was that it was necessary in any case to box the fuse in. A third series of experiments was also carried out in order to determine the cooling effect of the terminals on the fusing point of wires. He hoped to be able to supply tables which would show the currents required to fuse wires of various diameters and various metals. He would point out that the results were all very exact in his experiments, but considering that manufacturers do not supply very uniform wire, it is impossible to get absolutely precise results. He thought that a 10 per cent. margin was quite close enough for fuses. Double cut-outs are a great mistake in halls, rooms, and passages, as they can be easily tampered with and the lead short-circuited. The use of numerous cut-outs caused many bad joints, as screw-joints cannot be perfect. For small cut-outs, platinum wire was the best, as it did not oxidise. If the platinum is in view it acts as an indicator by becoming red-hot.

Prof. AYRTON said that he was at present engaged in making a large number of experiments on the fusing points of wires. For large wire the $\frac{3}{2}$ power law was correct, but for small wires the current would be proportional to the diameter simply; the reasons for this he had pointed out in his paper on "Portable Voltmeters."

Sir DAVID SALOMANS had found that the fusing of cut-outs had always been a bug-bear. There were two important points not touched on in the paper: 1st, nothing had been said of the effect of alternating currents on fuse wires; 2nd, how long would fuses remain constant? He had himself found that a fuse which would ordinarily go at 30 ampères, after continued use would not go with 100 ampères; the reason of this was doubtful, though the statement was a fact. He thought Mr. Cockburn had somewhat summarily dismissed magnetic cut-outs; he had himself found that these were the only fuses that could be entirely relied on; when once set they would always act with a set and definite current. The use of china bases for cut-outs, he considered bad, as they are extremely liable to crack when screwed up. He quite agreed with Mr. Preece that double cut-outs were sources of danger. General Webber had pointed out the desirability of having spring as well as screw contacts. The use of cut-outs to lamps was more necessary formerly than at present, as the lamps used to be badly made, and the regulation of the current was also bad. 7 or 8 lamps a year now only broke against 70 or 80 formerly, and cut-outs were not, therefore, so necessary now.

Mr. R. E. CROMPTON thought it was not fair for the statement to be made that the question of fuses had not been considered before the present time; he had put up an installation five years ago, in which fuses of tinned wire had been used, which had answered their purpose admirably. He thought that the question was not so much where to place the fuses as where to place the switches, these ought really to be placed at the points where the branch leads branch off. The weak points of insulation in lamps were the fittings and cut-outs. Slate was stated to be the proper material for switches and cut-outs, but some slate conducts and will bring down the insulation of an installation very low. There was nothing better, in his opinion, for cut-outs than hard wood, which he emphatically asserted would not ignite, a great deal of rubbish had been spoken on this point, and he protested against the restrictions which had been placed on electric light engineers, in consequence. Double cut-outs were, he agreed with Mr. Preece, an abomination; leads which ought actually to be far apart were brought together by their means.

Mr. BERNSTEIN considered the proper placing of cut-outs an important point; he knew of cases in which all cut-outs were placed on a slate board, and the arrangement answered perfectly. He had himself used one fuse to protect several lamps, and he considered that this was quite a sufficient protection.

Mr. BLAKESLEY thought that Mr. Preece's statement as to the action of shellac on wire was incorrect; the effects observed were more probably due to the shellac preventing radiation. When the metals used for fuses were those which expanded with heating, then bursting took place on a sudden fusion; for this reason foil was preferable to wire. An important point brought out by Sir David Salomans's remarks was that fuses did not act when they were wanted to, this being dependent upon the current being alternating or steady; an unsteady current was really of the nature of an alternating one.

Mr. FARQUHARSON agreed with Mr. Preece and Mr. Crompton as to the over-doing of cut-outs. With reference to Mr. Crompton's remarks, he had known a case in which hard wood would not have answered the purpose of porcelain or slate as a base for the fuses. He thought that the formation of oxide on the surface of tin wire was too thin to account for the effects observed by Mr. Cockburn. In several cases he had known wires to corrode when subjected to wet and a current, and then by their heating to fire their casing.

Mr. PREECE said that with reference to the effect of shellac, he had found a wire which ordinarily fused with 4·9 ampères, melted with 4·34 ampères when touched with shellac. The same wire when connected to terminals required 6·00 ampères to fuse it. As regards the formation of oxide, he would point out, in answer to Mr. Farquharson, that tin wire becomes red hot before it breaks down, although tin melts below a red heat.

Mr. CROOKES had found that chemically pure metals gave very uniform results as regards their fusing points, but a very slight impurity made the results differ as much as 25 per cent. The explanation given by Mr. Preece as to the effect of shellac was probably a correct one. In compound metals the metal of lower fusibility would melt first with a slowly increased current, but if the latter came with a sudden burst a different result would be obtained. He had a short time ago invented a cut-out worked on a new principle; this consisted of a nickel wire which was held back by being attracted against the poles of a permanent magnet, when a current passed through the wire and heated it the latter lost its magnetic properties, and fell away from the magnet and actuated a cut-out. He considered magnetic cut-outs of all kinds far superior to fuses.

Mr. ESSON thought that a great deal of nonsense had been talked about fires caused by fuses, &c.; he had only known one case of a fire, and that had been caused by a switch. The restrictions placed in the way of engineers were very cumbersome and unnecessary.

Mr. MORDEY had found that slate did not insulate for high tension currents unless well boiled in paraffin wax, when it insulated well; slate so prepared would not burn. With reference to magnetic cut-outs in which mercury contacts were used, the mercury was liable to be splashed about when the cut-out acted, but this could be prevented by placing a thin wire shunt across the cut-out, which stopped the sparking, and then could fuse itself. He considered Mr. Cockburn's fuse a very good idea.

Dr. FLEMING said, with reference to slate, that the latter differed greatly in quality. Serpentine was very good and could easily be worked.

Mr. HANCOCK pointed out that a short length of wire when it fused might do so all along its length, but this was not the case with a long wire, as the sag probably put a strain upon it and caused it to break at one particular spot. The position of the leaden ball in a Cockburn fuse was important, as the bending moment should have its correct value.

Mr. COCKBURN, in replying, agreed that in a fuse of thick wire the length must be longer than in the case of a thin wire. The tension wire used in Thomson's fuse was not a new idea, as he himself had tried springs but had not found them to answer satisfactorily, as the set of the springs continually altered. With reference to Mr. Hedges' queries as to tinfoil, the experiments he (Mr. Cockburn) had made were with the foil very carefully cut and gauged. He did not agree with Mr. Preece as to the use of platinum wire for fuses, as the latter when small were placed in covered boxes and could not be seen. As regards the experiments with shellac, the latter no doubt acts as a protection from radiation and also no doubt as a flux; he did not think that a fuse wire covered with shellac would act better than his own weighted wire arrangement. The size of terminals does, of course, make a great difference, but his fuses were adapted for boxes fitted with a particular size of terminals. The use of fuses was not only to guard against a sudden increase of current, but also against such a slow increase as might be dangerous. It was true that platinum melted like wax and without a sudden burst, but then weighted tin acted in the same way. He agreed that double pole cut-outs were dangerous, but every lead ought certainly to be protected. Soldered connections should be used as far as possible. Oxidation under screw heads may be prevented if connections are properly made. He agreed as to the law relating to the fusing of wires of small diameter. As to the deterioration of fuses under continual use, he had not found that this took place. He had not intended to disparage the use of magnetic cut-outs, but these could not be used on all local circuits on account of the expense. The use of china was not satisfactory for cut-out boxes. With regard to the use of wood for the boxes, he had known cases in which such had been burnt. Slate was objectionable as it became covered with moisture.

At the conclusion of the discussion Mr. BOHN exhibited a "Hydrophone," an apparatus for detecting the leakage of water in pipes. It consists of a long rod, the lower end of which is placed on the pipe, and the other end fitted with a sensitive microphone connected to a telephone receiver. The apparatus has been used abroad with considerable success.

The meeting then adjourned.

Physical Society, January 28th, 1888.

Professor W. C. ADAMS, F.R.S., Vice-President in the chair.

In opening the proceedings the chairman referred to the great loss which the society had sustained by the death of Dr. Balfour Stewart, their late President, and said that his loss would be deeply felt by the whole scientific world.

The following papers were read: "On the effect of magnetism on the thermo-electrical properties of bismuth," by Mr. HERBERT TOMLINSON. It has been shown by Sir William Thomson and others that the electrical resistance of an iron wire is increased when magnetised longitudinally, and similar phenomena were shown to occur in steel, nickel, cobalt and bismuth, in a paper communicated to the Royal Society in 1882 by the author.

On comparing the results, it is found that for the same intensity of magnetisation, the increase of resistance of bismuth is about two thousand times that exhibited by iron. The author believes the increase of resistance of bismuth to be partly *apparent* only, and thinks that some influence similar to an opposing E.M.F. is operative; but as to its exact nature he can say nothing. Hall's phenomenon suggests itself as a possible explanation, but experiment shows that this is not the true cause. The change of dimensions due to magnetisation is found to be too small to produce the effect, and so far no satisfactory explanation has been found. On heating

rod of bismuth when under the influence of magnetising force, an E.M.F. is set up from unmagnetised to magnetised across the hot junction, having a value of about ·0022 microvolt per 1° C. difference of temperature, when the magnetising force was 226 C.G.S. units. Ettinghausen has found that a difference of temperature is produced between the two sides of a plate of bismuth placed in a magnetic field, when an electric current is passed through it, and it has also been shown that if a thermal current be substituted for the electric current, a difference of potentials is produced.

"On the influence of magnetism and temperature on the electrical resistance of bismuth and its alloys with lead and tin," by M. ED. VON AUBEL. An abstract was read by Mr. BAILY. Some specimens of bismuth show an increase of resistance with temperature, whilst others show a decided decrease. M. Righi is of opinion that the decrease is due to the presence of tin, but the author's experiments on alloys show that this is not the case. Magnetism always produces an increase of resistance, but its influence diminishes as the temperature rises. It is concluded that the cause of the anomaly is still to be sought.

"On a water-dropping influence machine," by Prof. S. P. THOMPSON, D.Sc. In this apparatus only one jet of water is required, and satisfactory results are obtained without special insulation. It consists of three cylindrical metal vessels hung vertically over each other by silk strings, the highest and lowest being connected by a stiff metal wire. The highest is a small cylinder open at both ends; the lowest is an open pot which receives the water. The intermediate vessel is open at the bottom and is provided at the top with a funnel fixed so that its central aperture is about the middle of the cylinder. The water jet which must have a fine orifice is inserted about half way into the uppermost vessel.

"On the price of the factor of safety in lightning rods," by Prof. S. P. THOMPSON. It is here shown upon certain assumptions that the safety against fusion varies as: Total cost $\times \frac{f s}{\rho d l^2 k}$ where f = temperature of fusion of material above atmosphere, s = specific thermal capacity, ρ = specific electric resistance, d = density, k = cost in pence per lb., and l = length of the conductor. If the total cost and length are supposed to be given, the factor of safety = $\frac{f s}{\rho d k}$. Of the common metals, iron has the greatest factor of safety, being more than four times that of copper. Such being the case, the author thinks it desirable that the report of the Lightning Rod Conference be re-considered.

"On the optical demonstration of electrical stress," by Prof. A. W. RUCKER, F.R.S., and Mr. C. V. BOYS. A number of lecture experiments were shown, illustrating that electrical stress exists in the dielectric separating two charged bodies. The bodies were placed in carbon bisulphide, between two crossed nicols, and on electrifying them by means of a Holtz machine, light passed through the analyser. Two concentric cylinders gave a black cross on the screen similar to those seen on interposing a plate of some uniaxal crystal, and a model illustrating a charged Leyden jar was shown.

CORRESPONDENCE.

The Leamington Electric Lighting.

I have read with much surprise your leading article and following note on the Leamington installation. I can consider it only as a direct attack upon my company, it being well known to you and the trade that the underground cables used there were made by us.

As a matter of fact, no trouble has been experienced from them. They have neither short circuited, leaked nor fused, and are now, as they have always been, in thorough working order.

In the interest of electric light generally it is to be regretted that you did not obtain confirmation before publishing statements of which, as you admit, "we do not guarantee the absolute accuracy of all the details."

Those to which you have given currency are quite at variance with the facts, and show that no reliable information has been obtained, as the least knowledge of what happens would show that your theory does not touch the facts of the case.

The extinction of a portion of the lamps has occurred once, and occasionally twice, in a night during the month of January only, and not each night, but frequently with an interval of several days between. The extinction has lasted from 20 seconds to as many minutes, but in no case has, as you state, a portion of the town been plunged in total darkness for the whole of a week, the electric light having failed completely.

The particulars given of the discovery of the cause of the extinction are equally inaccurate. I am baffled quite as much to understand where you obtained the details you have published, which are as incorrect as they are precise, as I am in my endeavours to localise any defect, for whatever it is, it disappears as soon as it has done the mischief, leaving no trace behind, nor do the instruments give any warning of what is going to occur. The insulation of the cables remains unaltered, and there is neither fusing nor burning out, whilst on the trenches being opened in several places both they and the cables are found in good order.

I have yet to discover any place where our cables have become "disarranged," and the categoric assertion to this effect, and that two of the mains have become fused, can only be described as an untruth.

I am reluctantly forced to the conclusion that your informant has other purposes to serve than those of the electric light industry, otherwise such deliberate invention would not have been resorted to.

On the basis of these erroneous statements you freely criticise the quality of our cables. Your conclusions are quite unwarranted, and it appears to me that something more than hearsay evidence should have been obtained before expressing so positive an opinion.

I desire to correct an impression which you appear to have that our cables are used simply because they are the cheapest. They have been laid in nearly every large installation, both public or private, chiefly because they are believed to be superior in lasting qualities to anything else in the market. The rubber covering, whose exceeding excellence is so strongly urged by you, will prove a very indifferent insulation after a few years' exposure to damp and gas, and on the superiority on these points we are urging, and urging successfully, the use of our cables for underground mains.

I must also protest against the charge of false economy brought by you against the Midland Company. In neither channelling, cables nor laying has there been any question of saving money at the expense of good work. The trenching or method of laying can never have been seen by you, or they would not have been described as a rough and ready method. They were devised to meet difficulties of which your informant clearly has no idea.

It is easy to make charges in the way you have done in this case, but such recklessness and inaccuracy are not what are expected from a leading journal of the trade.

T. O. Callender.

The Westinghouse System.

In your numbers of 30th September, 7th and 14th October of last year, you published an article by Mr. F. L. Pope on the Westinghouse alternating system of electric lighting, extracted from the New York *Electrical Engineer*. I afterwards reviewed this article in your issue of 4th November, 1887.

My review appears to have been copied into the New York *Electrical Engineer*, and commenting on it, "An Observer" writes to say that there is generally a false impression as to the number of field magnets in the Westinghouse dynamo, that they number 10 instead of 16 as I stated.

Now there are four separate and careful drawings accompanying Mr. Pope's article, each showing that the number of field magnets is distinctly 16. Either therefore these drawings do not represent the machines as constructed, or else the Westinghouse Company must be making two types of dynamos, of which "An Observer" is only acquainted with one.

The question is not one which admits of controversy, but one which can only be set at rest by a statement from someone in authority who is really conversant with the facts.

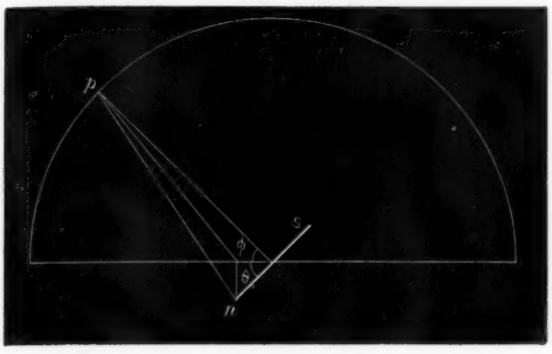
G. L. Addenbrooke.

February 1st, 1888.

Correction for the Length of the Needle of the Tangent Galvanometer.

In Kempe's Electrical Testing there is a formula by Joule and Jack, given to correct the error due to the length of the needle of the tangent galvanometer. As I have worked at the same problem and have published in this journal a result different from that given by Joule and Jack, I venture to give the method by which I arrived at my result. Perhaps some of your correspondents may be able to enlighten me as to the method by which Joule and Jack arrived at their result, or to point out an error in my formulæ.

Let R = the radius of the coil and r the half length of the needle or distance of the pole from centre of needle. Let θ = the deflection of the needle and ϕ the angle with the horizontal formed by any point in the coil.



Then the distance of p from n or s is

$$\frac{1}{\sqrt{(R\cos\phi \mp r\cos\theta)^2 + R^2\sin^2\phi + r^2\sin^2\theta}}$$

and the action of the current at p on both poles is

$$C\cos\theta\left[\frac{R\,d\phi}{(R\cos\phi - r\cos\theta)^2 + R^2\sin^2\phi + r^2\sin^2\theta} + \right.$$

$$\left. + \frac{R\,d\phi}{(R\cos\phi + r\cos\theta)^2 + R^2\sin^2\phi + r^2\sin^2\theta}\right]$$

$$= \cos\theta\, C\left[\frac{R\,d\phi}{R^2 + r^2 - 2Rr\cos\phi\cos\theta} + \frac{R\,d\phi}{R^2 + r^2 + 2Rr\cos\phi\cos\theta}\right]$$

Let $R^2 + r^2 = a$ and $2Rr\cos\theta = b$.
Then the action of the current at p

$$= C\cos\theta\left[\frac{R\,d\phi}{a - b\cos\phi} + \frac{R\,d\phi}{a + b\cos\phi}\right]$$

And the action of a quadrant of the current

$$= C\cos\theta\left[R\int_0^{\frac{\pi}{2}}\frac{d\phi}{a - b\cos\phi} + R\int_0^{\frac{\pi}{2}}\frac{d\phi}{a + b\cos\phi}\right]$$

$$= C\cos\theta\, R\left[\frac{\tan^{-1}\left\{\sqrt{\frac{a-b}{a+b}}\tan\frac{\phi}{2}\right\}}{\sqrt{a^2 - b^2}} + \frac{\tan^{-1}\left\{\sqrt{\frac{a+b}{a-b}}\tan\frac{\phi}{2}\right\}}{\sqrt{a^2 - b^2}}\right]$$

Now

$$\tan\frac{\phi}{2} = \tan\frac{\pi}{4} = 1$$

and

$$\tan^{-1}\left\{\sqrt{\frac{a-b}{a+b}}\right\} + \tan^{-1}\left\{\sqrt{\frac{a+b}{a-b}}\right\} = \frac{\pi}{2}$$

so that the action of a quadrant of the current upon the needle

$$= C\cos\theta\,\frac{R\frac{\pi}{2}}{\sqrt{a^2 - b^2}}$$

Substituting the value of a and b this becomes

$$C\cos\theta\,\frac{R\frac{\pi}{2}}{\sqrt{(R^2 + r^2)^2 - (2Rr\cos\theta)^2}}$$

Since this value = $H\sin\theta$

$$\therefore\quad C = H\tan\theta\,\frac{\sqrt{(R^2 + r^2)^2 - (2Rr\cos\theta)^2}}{R\frac{\pi}{2}}$$

In this formula the error becomes smaller as θ becomes greater.

The formula of Joule and Jack in the preceding notation gives

$$C = H\left\{\tan\theta + \tfrac{1}{2}(4\tan^2\theta - 1)\,\frac{r^2}{R}\sin 2\theta\right\}$$

This last formula does not appear to me to be at all a likely one.

W. Moon.

Electrical Measuring Instruments.

I notice in the article on practical electrical measurement, ELECTRICAL REVIEW of December 30th, 1887, by Mr. J. Swinburne, brief mention is made to one of my new alternating current instruments, for comparing the positions of the phases of currents in two circuits.

While so far as the principle of the action is concerned, the description given by Mr. Swinburne is perfectly correct, he is in error in stating that the effect of the inertia of the cores in the instruments must render their accuracy doubtful. The fact is that the cores, which are made of iron wire, have opposite them a little iron diaphragm, similar to a telephone diaphragm, the vibrations of which diaphragms are carried and multiplied by very light aluminium levers, having fulcrums devoid of lost motion, and a small mirror capable of oscillating in two planes at right angles to each other around its centre, one diaphragm giving one of the motions, and the other diaphragm the other motion.

I enclose a copy of a more complete description which I have just prepared for the *Electrical World*, New York.

Elihu Thomson.

January 13th, 1888. *Per G.*

How Electric Lighting is Retarded.

Some time ago a builder came to us to hire an installation of the electric light for use at a country house he was enlarging. He arranged for an arc light installation, and told us that he had a light already at work, but it was not enough. When our electrician arrived to fix the plant he found that the *light* (?), if you could call it such under the circumstances, consisted of a *hashed up lamp* made of parts of an old Brush lamp patched up by some ignorant person or persons who evidently thought that globes, hanging boards, and weather protectors to keep out the wet were facts not worth serious attention, so they were omitted, and the wires twisted round the hooks and lamp, left to the mercy of the winds and weather. The carbons supplied were far too small about ¼ inch diameter, and the *leads* consisted of 3 16s. galvanised iron telegraph wire with about 12 yards of No. 15 copper wire cotton covered near lamp, the whole being worked (?) by a single light old type Gramme machine; of course the light was not enough, being mostly out or just red. The foreman at the house said that they could not get proper carbons, and had to use short bits held together with card-board and wire. When we tell you that this job was put there by some people who style themselves electricians and electrical light engineers, and advertise largely as such, you will see that your remarks in Notes the other week were not far wrong. These people have never served an apprenticeship or worked in an electrical works, and their knowledge of the business must be about on a par with the M. E. referred to by "J. J." in your issue of 27th

inst. These people had a second lamp there, and had evidently expected to get the two to work on a single light machine and on the circuit of iron wire described.

P. Jolin & Co.

January 28th, 1888.

Electric Lighting at Bournemouth.

I have just seen a copy of the report of the surveyor of Bournemouth which appeared in your issue of January 27th. With much astonishment I read that "the alternating current transformer system does not depend in any way on the good working of any moving machinery."

As the estimates of the E. P. S. Company for utilising the spare energy at the refuse destructor in Bournemouth passed through my hands, I feel bound to state that such an extraordinary distortion of facts did not emanate from me. If you will refer to my article on "The Storage of Electricity," which you noticed so favourably, you will find that I referred to the breaking down of the transformer system at Terry's Theatre and at the St. James's Hall, owing to a defect in the "moving machinery."

There are so many "electrical tinkers" about, possessing only a superficial knowledge of even the elementary principles of the science, ever ready to give misleading information to local authorities, that it would be well for municipal officials to appeal to the superintending engineer of one of the big electric lighting firms when an important question requires a reliable answer.

In the same report I notice 25 arc lamps of 1,000 candle-power each instead of 3,000 C.P. This is doubtless a clerical error, but the information offered to the commissioners of Bournemouth, *re* transformers, is unique. Surely the gentleman who penned such an extraordinary statement must have had the storage system in his mind at the time.

William Lynd, M.S.T.E.

Kennedy's Dynamo.

We notice a letter in your paper of 27th inst. from Mr. Kennedy, in which he seems to place much value upon his "single bobbin" design of dynamo.

We discarded the pattern after making a few, as we found the leakage of magnetism very difficult to avoid.

This seems a question which has received but little attention at the hands of electricians, and it would be interesting to hear the experiences of different dynamo makers upon this point.

F. H. Royce & Co.

January 30th, 1888.

Compound Winding.

Referring to your statement on page 93 of the ELECTRICAL REVIEW of the 27th inst., with reference to Messrs. King, Brown & Co., of Edinburgh, and the Anglo-American Brush Electric Light Corporation, Limited, it is right that I should inform you that my directors did not consider it necessary to institute proceedings against that or any other firm until the issue of the suit which had been pending in other quarters.

Immediately this suit was disposed of, my board repeated their invitation to Messrs. King, Brown & Co., to take a license; and, upon their declining to do so, not a day was lost in commencing proceedings in the first case of infringement by them in this country which the Brush Corporation were able to discover.

Messrs. King, Brown & Co. were notified to this effect, and the proceedings were initiated before their summons for so-called intimidation was taken out.

E. Garcke, *Manager and Secretary,*
ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION LIMITED.

February 1st, 1888

Electropathic Belts.

The thanks of the medical profession, and particularly of the public, are due to you for the complete *exposé* you have given in your issue of the 27th ult. of the tricks perpetrated on the latter by manufacturers of so-called electropathic belts, magnetic chest protectors, and other appliances of the kind.

The idea that many of the ills to which the flesh is heir is due to a deficient amount of electricity in the body is deeply rooted in the minds of many persons, particularly of those suffering from gastric derangement, sluggish liver, or irritability of the nervous system, giving rise to feelings of mental depression and exhaustion, inability to brace themselves up to work, and headaches. These persons, rather than take proper medical advice, fly to panaceas, such as you have had brought under your notice, by the mere use of which they expect to be cured, quite irrespective of the cause of their ailment, which is frequently unknown to them. Such persons never seem to think of questioning for a moment the efficacy of the appliance they purchase, or its suitability to their case, and believe with the utmost credulity in the wonderful cures it is said to have accomplished so graphically described in advertisements and testimonials, a goodly proportion of which are from reverend gentlemen whose opinions are as ostentatiously paraded as if they were to be equally implicitly relied upon in things medical as in things spiritual. Almost every physician can tell of instances where otherwise most sensible and wordly-wise men of business have consulted him regarding their health after having worn these and similar appliances, on which they have spent considerable sums of money to no purpose. Though it is incredible the number of persons who are duped by vendors of these useless wares, it is still more incredible that the class who are especially taken in are persons of considerable education and knowledge of the world. The majority of medical men are sufficiently acquainted with the nature of these appliances to know their uselessness for the purposes they are offered to the public, though few possess the necessary apparatus to demonstrate their inefficiency in the way you have done. Your experiments are therefore very valuable and will, I hope, find their way into the medical journals. Medical opinion, however, can do comparatively little against the perverted ideas of the mind in that portion of the public who hail quacks as the greatest benefactors of mankind, and tinker themselves up with every kind of patent medicine or mystical appliance until dire necessity forces them, often too late, to seek trustworthy medical advice. Such persons are more influenced by the daily press than by any amount of medical preaching, which is considered by them to be nothing else than the cry, "The craft is in danger." I quite agree with you that the subject is one which the daily press might take up with great advantage to the public weal. That some persons have derived benefit from the use of these belts and protectors is undoubtedly true. The mind is a powerful factor in treatment, particularly of minor derangements of the nervous system. Again, fashion and opinionativeness are powerful opponents of the doctor's advice. Mystical treatment has a pecular fascination for many persons who, when so spell-bound, will carry out directions which would not be listened to from the lips of the orthodox physician, and it is easy to understand how the protection afforded by these appliances to delicate parts of the body, often lightly clad or entirely unprotected from the vicissitudes of an English climate, will materially improve the condition of the wearer, though the improvement is in no way due to the electrical or magnetic qualities of the apparatus, but only to the flannel or leathers of which it is formed. I have heard of a French physician who removed those metal discs from some electrical belts and substituted wooden ones, in order to test the effect on the patients. The results he obtained were, according to his patients' account, wonderfully successful!

J. G. Garson, M.D.